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SUGARBEET RESEARCH

1981 REPORT

A Report to and for
the Sole Use of Cooperators
NOT FOR PUBLICATION

FOREWORD

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The report presents results of investigations strengthened by contributions received under Cooperative Agreements between Agricultural Research Service, U.S. Department of Agriculture, and the Beet Sugar Development Foundation; the California Beet Growers Association, Ltd.; the Farmers and Manufacturers Beet Sugar Association; and the Sugarbeet Research and Education Board of Minnesota and North Dakota.

Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

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SUGARBEET RESEARCH

1981 Report

Section A

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SUMMARY OF ACCOMPLISHMENTS, 1981

INTERSPECIFIC HYBRIDIZATION STUDIES--A self-compatible sugarbeet germplasm line resistant to the sugarbeet nematode is in the process of being released. The distribution of chromosomes and transmission of nematode resistance of a triploid sugarbeet was studied. Chromosome numbers of the triploid ranged from diploid to tetraploid, and all chromosome numbers between 18 and 27, except 21 and 23, were produced. Progeny plants in tetraploidy were probably developed from fertilization of restitution triploid megaspores, or from doubling of diploid zygotes. Transmission of nematode resistance through the triploid as female parent was 23.5%. Meiotic abnormalities were observed in the pollen mother cells of the triploid, with the occurring of chromatid bridges, micronuclei and restitution nuclei. The Beta trigyna x B. vulgaris hybrid B_2 progeny seems to have inherited little, if any, curly top resistance. M. H. Yu.

VARIETY TRIALS--Variety trials 181 through 1081-1 at Salinas were planted in December 1980 and harvested in September-October 1981. The winter was mild and the beets grew well with little bolting. In this set of variety trials, incidences of diseases were very light and there were no apparent stresses due to low fertility or drought. Root yields up to 50 tons per acre with 18 to 21% sucrose were common. Sugar yields ranged from 16,000 to 20,000 lbs. per acre. Similar yields were achieved by some commercial growers. A Spreckels grower at Gilroy produced greater than 53 tons/A at 16.4% sucrose on 63 acres. At Salinas, a Spreckels grower produced greater than 18,000 lbs. sugar per acre (57.7 T/A at 15.7% sugar) from a 28 acre field. A Union grower at Greenfield produced 17,500 lbs. per acre from a 57 acre contract. Thus, the high yields reported in our trials are not out of line with the "World Records" produced in nearby commercial fields. Despite the high yields and favorable growing conditions, variety differentiation was not good in these December planted trials. Apparently, without the significant impact of diseases to produce differential performances, most entries had similar yields. The yield similarities among test hybrids may reflect the narrow gene pool base of the disease resistant germplasm used in the program at Salinas. A continuing objective of the program will be the infusion of high performing germplasm with reselection for combined disease resistance. I. O. Skoyen and R. T. Lewellen.

VIRUS YELLOWS--Selection for resistance to virus yellows was continued in 1981. Selections were made within both multigerm and monogerm populations. A combination of severe isolates of BYV and BWYV was used as inoculum. A moderately yellows resistant line, C46, was released for increase by the BSDF. C46 is similar to C36 but has improved resistance to powdery mildew and slightly improved sucrose content. At the time this report was written, the analyses of six virus yellows trials (Tests 1781-2281) were not completed and summaries of these tests are not included in this report. These results will be provided to contributors of BSDF Project 12 when they are completed. They will also be included as part of the 1982 Report. R. T. Lewellen and I. O. Skoyen.

EFFECTS OF MASS SELECTION ON GCA--There is still considerable confusion on the ability of mass selection in sugarbeet to improve combining ability for yield. Mass selection has been highly successful as a means of improving populations for disease resistance, bolting resistance, plant and root shape and conformation, etc. As part of the yellows resistance breeding program at Salinas, mass selection based on sugar yield has been the criterion for making selections. Spaced plants are uniformly inoculated with BYV/BWYV or with just BWYV. Individual roots are then selected on the basis of root size and % sucrose (i.e., gross sugar yield). In addition to attempting to identify the genetic variability for yellows resistance, this procedure may also identify differences in yield potential among individual plants. Hybrids from four sets of open-pollinated lines were evaluated in 1981 (Test 1281) for yield under essentially yellows free conditions. All hybrids used 546H3 as the common female. The four sets of hybrids were differentiated by pollinators that were either the original source population or the lines derived from them by mass selection. The four open-pollinated sources were US 22/3, 468 (US 75), 915 (US 15), and 959 (US 56/2). The corresponding lines derived by mass selection are E937 (11 cycles of selection), Y930 (5 cycles), Y923 (4 cycles), and Y926 (4 cycles), respectively. The results of Test 1281 suggest that each source was improved in combining ability by mass selection. Improvements ranged from 3 to 6% in gross sugar yield. Not all sources responded the same. Whereas most of the improvement in US 56/2 was for increased sucrose content, the improvement in US 15 was primarily for root yield. These sources and their mass selected derived lines were also evaluated in Test 2281 to determine the concurrent improvements in resistance to virus yellows. R. T. Lewellen and I. O. Skoyen.

PERFORMANCE OF CORRESPONDING 3-WAY AND DOUBLE-CROSS HYBRIDS--In the development of topcross pollinators for the production of 3-way hybrids, lines are often produced with potential for commercial use except for the occurrence of one or more major deficiencies. For example, lack of sufficient resistance to virus yellows or curly top might preclude their use in California. One means to overcome or ameliorate certain deficiencies might be to combine two lines that possess complementary traits into a single pollinator. With the use of the red hypocotyl marker, true F_1 plants can readily and accurately be identified between green hypocotyl seed parents and red hypocotyl pollen parents. Then these F_1 plants or their increases could be used as the pollinator. To test the feasibility of combining complementary pollinator lines, corresponding hybrids were produced with the original topcross pollinators and their F_1 hybrid combinations. Lines chosen for this study were C37 (rr) crossed to C31 (R-) and Y41 (R-). C37 is not closely related to C31 or Y41 and these lines complement each other for differences in performance and disease resistance. For example, C37 is a low sugar type with good resistance to virus yellows and curly top but low resistance to powdery mildew. C31 and Y41 have higher sugar contents but are more susceptible to virus yellows and curly top but have better resistance to powdery mildew.

Summary of performance of hybrids with C37, C31, and Y49 = F_1(C37 x C31) from Tests 481, 781, 881, B181, and B381.

	Description	Sugar Yield (lbs/A)	Root Yield (T/A)	% Sucrose
C37 hybrids	3-way	14,500	39.8	18.1
C31 hybrids	3-way	14,900	40.0	18.5
Y49 hybrids	Double cross	15,000	40.8	18.3

Summary of performance of hybrids with C37, Y41, and Y52 = F_1(C37 x Y41) from Tests 481, 781, and B181.

	Description	Sugar Yield (lbs/A)	Root Yield (T/A)	% Sucrose
C37 hybrids	3-way	14,700	39.7	18.5
Y41 hybrids	3-way	15,100	40.2	18.8
Y52 hybrids	Double cross	15,300	41.2	18.6

The expectations based upon additive effects would be for the performance of the hybrids produced with the F_1 pollinators (double-cross hybrids) to be equal to the average of the two 3-way hybrids. This was so for sucrose content. However, for root yield and sugar yield the double-cross hybrids were consistently better than the average of the 3-way hybrids and usually better than that of the high 3-way hybrid. This suggests that some epistatic effects were occurring and that there may be a yield advantage by using F_1 pollinators. However, even though we tried to grow these tests under disease free conditions, the yield advantage of the double-cross hybrids may be due to better buffering against the effects of several diseases, e.g., virus yellows and powdery mildew. In trials to evaluate disease resistance, the reactions of double-cross hybrids were usually intermediate to those of the 3-way hybrids for virus yellows, powdery mildew, curly top, and bolting. By using the hypocotyl marker to identify F_1's, it may be difficult to produce sufficient F_1 seed for commercial use. However, it would be relatively easy to produce large quantities of F_2 seed for use as a commercial pollinator. Studies are continuing to determine if hybrids produced from F_2 pollinators have the same relative performance as those produced from F_1 pollinators. R. T. Lewellen and I. O. Skoyen.

ASSOCIATION BETWEEN LINE AND HYBRID PERFORMANCE--In the absence of significant inbreeding depression, there appears to be an association between the performance of pollinator lines per se and the performance of their hybrids. For example, among open-pollinated lines, this relationship is evident in Tests 681, 1181, 1281, etc. This same relationship has been repeatedly observed for random-mating monogerm populations and their hybrids. For example, the hybrids with population 755 have the best hybrid performance (Test 981) and populations 741 and 742 the poorest which is the same ranking as the populations per se. Other things being equal, knowledge of these relationships may be of value when choosing sources for initiating population improvement by cyclical selection or for extracting improved lines. R. T. Lewellen and I. O. Skoyen.

EARLY GENERATION TESTING--A reliable evaluation of hybrid performance in early generation lines would be very desirable and increase breeding efficiency. From monogerm, self-fertile population 755, over 200 S_1 lines were produced and topcrossed with C37. Based upon type-O, monogermity, and percent germination, 112 of these test crosses were evaluated for performance at Salinas and Brawley. The randomly selected S_0 plants of 755 were known to be heterozygous for genetic male sterility (Aa), thus the S_1 families segregated for male sterility. In the crossing block the fertile plants were rogued and 6 to 10 male sterile plants were allowed to outcross with the C37 tester. In addition, a variety hybrid was produced between the 755 source population and the tester. Results from the evaluation trials indicated that the variety hybrid had slightly better performance than the mean of the testcrosses for sugar yield. Only a few of the testcrosses were significantly superior to the variety hybrid check. These preliminary results suggest that there was little variability for differences in hybrid performance in this source, that early generation testing for hybrid performance is not highly reliable, or that these trials were not precise enough to distinguish differences. Even though these results are somewhat discouraging, the evaluation of early generation testing will be continued. S_1 stecklings from the best lines will be recombined to determine if the performance of the population has been improved. R. T. Lewellen and I. O. Skoyen.

EFFECTS OF SELECTION WITHIN SELFED PROGENIES ON HYBRID PERFORMANCE--In our program S_1 family progeny testing within self-fertile, monogerm populations has been shown to be an effective way to shift population means for a number of traits including root yield, sucrose content, sugar yield, components of impurity, and disease resistance. Only limited information has been obtained on the ability of S_1 selection to improve combining ability or hybrid performance. S_1 progeny testing has not been evaluated as a means of improving self-sterile, multigerm pollinators for hybrid performance. At Salinas, insufficient selfed seed is obtained from self-sterile genotypes to evaluate this selection method within traditional pollinators. However, a self-fertile near-equivalent of C17 has been developed, and selection within the selfed generations of this line provided an opportunity to evaluate the effects of selecting within selfed progenies on hybrid performance. The self-fertile sister lines 717 and 719 were derived from the fourth backcross of C17 to a self-fertile source. These lines are highly self-fertile and little outcrossing occurs. Starting in the S_2 generation, two cycles of bulk population selections were made. Selection was for resistance to virus yellows, Erwinia soft rot and gross sugar yield but with emphasis on sucrose content. Seed from selfed plants was bulked and sufficient plants participated so that little random drift should have occurred. That is, except for the influence of selection, the gene frequencies in 717 and 719 lines should be similar to the closely bred C17 or the closely related lines C36 and C37. As lines per se, 717 and 719 are highly uniform, have very small dark-green canopies, and produce short seed stalks. To test for the effects of selection within selfed progenies on hybrid performance, corresponding experimental hybrids involving three female parents were compared for C17 (C36, C37) and the 717/719 pollinators. In 15 comparisons over 3 years (1979-81) the following results were obtained:

	Sugar Yield (lbs/A)	Root Yield (T/A)	% Sucrose
717/719 hybrids	12,000	36.1	16.6
C17, C36, C37 hybrids	11,600	35.9	16.0

Thus, it appears that selection within selfed progenies on an individual beet basis was effective at changing the hybrid performance of C17 type pollinators. The primary change was for improved sucrose content. Selected plants within the 717/719 lines could not be recombined, so it was not possible to actually evaluate a recurrent or cyclical selection program within these sources. However, based upon the insights and results from the selections within 717/719, multigerm, self-fertile source populations with greater genetic variability than C17 are being developed to test recurrent selection based upon S_1 family evaluation as a means to improve pollinators for hybrid performance while concomitantly improving disease resistance. R. T. Lewellen and I. O. Skoyen.

GENETIC ADVANCE FOR YIELD AND DISEASE RESISTANCE IN SUGARBEET--A second year's testing to evaluate the approximate genetic contribution to the 60+ percent increase in sugarbeet yield in California since the mid-1930's was conducted under common environments at Brawley and Salinas. Common environments should mitigate that portion of the 60% improvement in yielding capacity due to changes in cultural practices and crop management. The first year's test comparisons were reported in Sugarbeet Research, 1980 Report, pages A5, A17, A26, A27, A36, A37, A39, A49. Representative cultivars included at both locations in 1981 were R&G Pioneer, US 15, US 22/3, US 56/2, US 75, US H6, US H7A, and US H10B. Disease evaluations were made at Salinas in 1981 (Test 2081) but analyses were not completed in time to be included in this report. 1981 test results are summarized in tabular form for Tests 681A, 1181A, and B481. As in 1980, test results at Brawley and Salinas suggested that a significant portion of the yield increase can be attributed to genetic improvement. Yield improvement appeared to be nearly linear both years and no yield plateau in sugarbeet variety improvement was apparent. A summary of gross sugar yields in % of US 22/3 for 1980 and 1981 reflect the upward trend of yields as improved varieties have become available:

Variety	Year of Release (Circa)	1980[1/] %	1981[2/] %
US H10B	1970	149	138
US H7A	1964	144	139
US H6	1960	131	124
US 75	1952	125	120
US 56/2	1950	127	121
US 15	1936	131	123
R&G Pioneer	Pre-1940	111	105
US 22/3	1948	100	100

1/ Average of 2 tests.
2/ Average of 3 tests.

Results from both test years confirm that sucrose concentration has improved only slightly over the span of the use of the representative cultivars. The reactions to curly top and virus yellows have been significantly improved but more importantly, perhaps, than the tolerance to disease stresses, has been the steady improvement in yielding ability that has accompanied the incorporation of disease resistance, nonbolting tendency, conversion to hybrid varieties and monogerm seed character. The origin of susceptibility to powdery mildew and Erwinia root rot, diseases of recent severe impact on sugarbeet culture, can be traced to the primary germplasm sources used to develop the succession of obsolete and modern cultivars. The insights gained from two years of this study and the comparison of commercial cultivars with experimental hybrids and unadapted cultivars suggest that significant gains can continue to be expected from sugarbeet breeding research. I. O. Skoyen and R. T. Lewellen.

ERWINIA ROOT ROT--Selection for resistance to ERR was continued in 1981. Selections were made from both greenhouse and field plantings. Greenhouse testing was found to be a reliable technique for upgrading levels of resistance. Based upon the reaction of common checks, there is a good association between greenhouse and field reactions. A limited number of non-California and European cultivars and breeding lines were field tested. In general, non-California material is highly susceptible to Erwinia. R. T. Lewellen, E. D. Whitney, and I. O. Skoyen.

FODDER BEET TESTS--In cooperation with other beet research locations, the gross sugar yield of fodder beets was determined in comparison to locally adapted varieties. The results of the Salinas test (10-C) are included in the Logan summary. A test of fodder beets was also grown in the Imperial Valley (Test B681). In the Imperial Valley test, all entries exceeded the gross sugar yield of US H11 and an anisoploid fodder beet variety 'Oscar' had 36% greater sugar yield than US H11 or a theoretical yield of 890 gallons of ethanol vs. 660 gallons for US H11. R. T. Lewellen and I. O. Skoyen.

DIVERGENT SELECTION FOR ROOT TOUGHNESS--Testing was continued in 1981 on divergent selections for low fiber (soft) and high fiber (tough) sugarbeet roots vs. the effect of environment on root fiber. Preliminary results from two 1981 tests (381-1 seeded in December 1980 and 381-2 seeded in March 1981) were similar to those reported in Sugarbeet Research 1980 Report, pages A5, A53-A56. Complete test analyses were not available in time for inclusion in our 1981 report. A second cycle of divergent selection was made in 1981 to evaluate the potential of further progress in developing low fiber and high fiber lines. I. O. Skoyen and R. T. Lewellen.

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1981

DUFFUS, JAMES E. Beet western yellows virus - A major component of some potato leafroll affected plants. Phytopathology 71:193-196. 1981.

Beet western yellows virus (BWYV) has been isolated from potato stocks with typical potato leaf roll (PLR) symptoms. Virus isolates from potato, that induce leaf rolling, interveinal chlorosis, petiole epinasty, and reduction in leaf size in Physalis floridana and interveinal chlorosis on Capsella bursa-pastoris have been shown to be strains of BWYV. Isolates differing in host reaction and serological characteristics have been found in individual potato plants indicating a complex etiology for the PLR syndrome. In addition to potato, and other solanaceous hosts, one isolate has been transmitted to and recovered from species in the Boraginaceae, Chenopodiaceae, Compositae, Cruciferae, Leguminosae, Malvaceae, and the Portulaceae. The BWYV isolates induce primary leaf roll symptoms in PLRV-free and virus-free potato cultivars, indicating that these isolates might easily be confused with "typical" PLRV. Preliminary serological data indicate that there are several serotypes of BWYV in potato that differ from each other and from PLRV in serological reactions. This evidence suggests that serological testing for PLRV occurrence would probably give misleading information. The broad host range of these BWYV isolates raises questions about the reinfection of virus-free potato stocks from infected wild hosts in "isolated" areas.

DUFFUS, JAMES E. Curly top virus control. Pages 508-510, In Proc. IX International Congress of Plant Protection. Burgess Pub. Co., Minneapolis, 1981. (Book Chapter).

Beet curly top virtually destroyed the sugarbeet industry in the western United States following World War I. The disease was the principal limiting factor to sugarbeet production from the early 1900's until World War II. Curly top has been held to less than catastrophic proportions by a complex control program involving a number of facets of agriculture and which includes the use of: 1) cultivars resistant to the virus; 2) cultural practices to delay infection; 3) vector control in the crop; 4) vector control in non-crop production areas; 5) reduction in leafhopper breeding areas; 6) and reduction in virus sources. In spite of the effective reduction of economic losses induced by curly top over the past several years, the disease is still present and changing along with the ecology of the California production areas. These changes demand constant attention to the present control procedures as well as to future ones.

DUFFUS, JAMES E. Distribution of beet western yellows virus in potatoes affected by potato leaf roll. Plant Disease 65:819-820. 1981.

Beet western yellows virus (BWYV) was isolated from most potato leaf roll-affected potatoes assayed from California, Oregon, Wisconsin, Maine, and British Columbia. These BWYV entities that cause typical leaf roll in potato may represent a continuum of isolates varying in host range and serologic reaction.

DUFFUS, JAMES E. Epidemiology and control of aphid-borne virus diseases of California. In Plant Virus Disease Epidemiology. Blackwell Scientific (In press). 1982. (Book Chapter).

Vegetable and field crops grown in the central coastal area of California have experienced severe and destructive attacks by aphid transmitted viruses. Control procedures instituted for some of these diseases based on transmission and epidemiological factors of the disease have vastly increased yields and quality of the area's important crops.

DUFFUS, JAMES E. and G. R. JOHNSTONE. Beet pseudo-yellows virus in Tasmania - The first report of a whitefly transmitted virus in Australasia. Australasian Plant Pathology (In press). 1981.

Beet pseudo yellows virus, transmitted by the greenhouse whitefly, was reported by the author from California in 1965. At that time, the potential economic importance of this disease was pointed out because of the world-wide distribution of the vector and damage that the virus can induce on greenhouse crops. The disease has recently been reported from Europe causing severe economic losses in greenhouse lettuce and cucurbits. The study in Australia constitutes the first record of this disease and whitefly transmission of a plant virus in Australasia.

DUFFUS, JAMES E. and G. R. JOHNSTONE. A probable long time association of beet western yellows virus with the potato leafroll syndrome in Tasmania. Aust. J. Exp. Agric. Anim. Husb. (In press). 1982.

Beet western yellows virus (BWYV) was isolated from potato cultivars showing leaf roll in Tasmania. Twenty-four of 25 plants representing 11 cultivars selected from the field as showing typical leaf roll symptoms contained virus which infected Capsella bursa-pastoris (L.) Medic. Serological tests with two isolates showed them to be closely related to several California BWYV isolates. Because of strict plant quarantine and certification schemes operating in Tasmania since the early 1930's, these isolates of BWYV are probably representative of leaf roll isolates that were common prior to world-wide certification schemes. The occurrence of BWYV in potatoes during these early periods strongly indicates a world-wide significance of BWYV in potato culture. The widespread occurrence of BWYV associated with leaf roll in Tasmanian potatoes could have very important practical consequences for the potato certification scheme. These are discussed together with the use of sensitive serological tests to detect luteoviruses in potato and facilitate their control.

DUFFUS, JAMES E., G. M. MILBRATH, and RAYMOND PERRY. A unique type of curly top virus and its relationship with horseradish brittle root. Plant Disease (In press). 1982.

A curly top virus-like entity, transmitted by Circulifer tenellus, was isolated from horseradish plants (Armoracia rusticana) affected by brittle root and also from non-brittle root-diseased plants in the same fields in Illinois. Inoculation of healthy horseradish with the virus did not result in brittle root under the greenhouse and field conditions in these tests. The virus from horseradish was serologically related to beet curly top virus and was transmitted in a similar manner by the leafhopper vector, but was unique from all known curly top types in its very limited host range of cruciferous species.

ESAU, KATHERINE and LYNN L. HOEFERT. Beet yellow stunt virus in the phloem of Sonchus oleraceus L. J. Ultrastruct. Res. 75:326-338. 1981.

Plant viruses that affect the phloem of host plants interfere with normal food movement. Beet yellow stunt virus is such a plant virus. The pathogenic response of the plant first appears as a vesiculation and the vesicles contain fibrils that resemble DNA fibrils of chloroplasts and mitochondria. These fibrils are postulated to be viral RNA and are precensors of virus particles in affected cells. Knowledge of the pathogenic effects of viruses in host plants can be related to physiological and virological studies and to ultimate control of such disorders through thorough knowledge of virus multiplication, movement in the plant, and effects upon the host.

JOHNSTONE, G. R., J. E. DUFFUS, D. MUNRO, and J. W. ASHBY. Purification of a Tasmanian isolate of subterranean clover red leaf virus and its serological interactions with a New Zealand isolate and other luteoviruses. Aust. J. Agric. Res. (In press). 1982.

A Tasmanian isolate of subterranean clover red leaf virus (SCRLV) was purified and concentrated from pea (Pisum sativum L. cv. Puget) by tissue extraction with cellulase followed by heat clarification, precipitation with polyethylene glycol in salt, and differential and density gradient centrifugation. Virus particles were isometric and 27 nm in diameter. Aulacorthum solani (Kalt.) acquired virus particles from the preparations through Parafilm membranes and transmitted them to healthy subterreanean clover test seedlings, causing disease symptoms of SCRLV. Isolates of SCRLV from Tasmania appeared identical with those from New Zealand on the basis of particle morphology and serological tests.

McFARLANE, J. S. Fusarium stalk blight resistance in sugarbeet. J. Amer. Soc. Sugar Beet Technol. 21:175-183. 1981.

Sugarbeet seed crops grown in the Willamette Valley of Oregon are frequently severely damaged by stalk blight caused by Fusarium oxysporum f. sp. betae. A wide range in resistance occurs among breeding lines ranging from no injury to death of all plants. The partially inbred lines 562 and 563 that are extensively used as parents in commercial hybrid varieties are susceptible. A resistant selection was made from the 563 line. Resistance was found to be dominant. No close linkage was demonstrated between susceptibility to stalk blight and the monogerm character. Resistance is controlled by more than one gene.

McFARLANE, JOHN S. Breeding sugarbeets adapted to California. The Calif. Sugar Beet 1981 Annual Report, pp. 30-34. 1982.

This is a popular article describing the past, present, and future of sugarbeet breeding in California. Breeding work was started in 1918 to select for curly top resistance. Our present cultivars are all monogerm hybrids with resistance to bolting, curly top, virus yellows, and Erwinia root rot. A need exists to include nematode resistance, powdery mildew resistance, and a higher sucrose concentration. The article serves to advise the California sugarbeet grower of USDA breeding accomplishments.

McFARLANE, J. S. Registration of two sugarbeet parental lines. Crop Sci. (In press). 1982.

The parental sugarbeet lines C566 and C566 CMS possessing resistance to stalk blight are being registered with the Crop Science Society of America. The lines are recommended as possible replacements for closely related parental lines that are stalk blight susceptible and are widely used in the production of commercial sugarbeet hybrid cultivars. Stalk blight is a serious disease in the Willamette Valley of Oregon, the major sugarbeet seed producing area of the United States.

McFARLANE, J. S., I. O. SKOYEN, and R. T. LEWELLEN. Registration of five sugarbeet germplasm lines. Crop Sci. (In press). 1982.

Five sugarbeet germplasm lines possessing bolting and disease resistance are being registered with the Crop Science Society of America. The lines represent the accumulated efforts of more than 25 years of research in sugarbeet breeding and genetics. The lines will fill a need for highly uniform inbreds and male steriles for use in genetic and physiological studies.

STEELE, ARNOLD E. Nematodes parasitic on sugarbeet. Chapter XII In Plant and Insect Nematodes, edited by W. R. Nickle. Marcel Dekker, Inc., NY, NY. (Accepted for publication). 1982.

This chapter is part of a larger textbook written for teachers, researchers, and students of plant pathology and nematology. The greatest effort is on the sugarbeet nematode, Heterodera schachtii, which probably accounts for in excess of 90% of the damage to sugarbeet caused by nematodes. In addition, nematode species of seven genera of economic importance in sugarbeet and more briefly, of nematodes of lesser importance, are discussed. The chapter contains 252 literature citations, 3 tables, and 38 illustrations. The text brings together the latest research findings on Heterodera schachtii and Heterodera trifolii.

WHITNEY, E. D. The susceptibility of fodder beet and wild species of Beta to Erwinia. Plant Disease 65: (In press). 1982.

The use of fodder beet and fodder beet x sugarbeet has been proposed for alcohol production. Also, the wild Beta species have been suggested as sources of genetic variation for increasing yield and disease resistance. This study shows the need for an Erwinia breeding program if these domesticated beets are to be used in areas such as California and Arizona for alcohol production or the wild species as sources of new genes to improve the domestic beet because susceptibility to Erwinia is common in these beets.

YU, M. H. Sugarbeets homozygous for nematode resistance and transmission of resistance to their progenies. Crop Sci. 21:714-717. 1981.

Heterozygous sugarbeet nematode-resistant, self-compatible sugarbeet plants were self-pollinated in the greenhouse; self-incompatible plants were inter-pollinated; and nematode-susceptible plants derived from resistant parents were sib-crossed in isolation chambers. Among the 184 S_2 and F_3 families from resistant parents, five were 100% nematode-resistant. These were the

first homozygous resistant families to be reported. The results indicated that 2.7% of the resistant S_1 and F_2 plants and only 1.1% of all plants, resistant and susceptible, were homozygous for nematode resistance. The remainder of the resistant S_1 plants produced approximately 41.8% resistant progeny. Plants from these true-breeding families transmitted resistance to 98.4% of their progeny in the following generation. The remaining 1.6% were moderately resistant. Two supposedly S_2 progeny plants from a resistant homozygote transmitted resistance to less than 50% of their self-pollinated progeny. These plants probably resulted from outcrosses. These findings suggested that resistant homozygotes as seed parents gave full transmission of nematode resistance. Resistant heterozygotes derived from testcrosses to these homozygotes acquired little enhancement in rate of transmission of resistance. Nematode resistance is probably conditioned primarily by complementary genes. In parental line breeding and development after the F_1 generation, it would be necessary to use progeny testing to identify true-breeding individuals.

INTERSPECIFIC HYBRIDIZATION

M. H. Yu

Cytogenetical Observations of the Nematode-Resistant Triploid Sugarbeet

The triploid sugarbeet selection 6122, resistant to the sugarbeet nematode, Heterodera schachtii Schm., was spontaneously derived from a resistant diploid seed parent. Reciprocal crosses of this triploid, heterozygous nematode-resistant sugarbeet, and diploid susceptible C17 plants resulted in low seed set from either side of the parents. A total of 227 seedlings were obtained for the study. There were 149 plants from 6122/C17 and 78 plants from C17/6122 (Table 1).

Table 1. Inheritance of parental chromosomes and nematode resistance of the resistant triploid sugarbeet 6122 in reciprocal crosses with susceptible diploid C17 plants.

Chromosome Number	6122/C17			C17/6122		
	NR	NS	Sum	NR	NS	Sum
18	11	44	55	2	41	43
19	12	39	51	1	0	1
20	2	7	9			
22	0	1	1			
24	1	2	3			
25	1	0	1			
26	2	4	6	1	0	1
27	2	10	12			
34	1	0	1			
36	2	0	2			
38	0	1	1			
Others	1	6	7	0	33	33
Total	35	114	149	4	74	78

Chromosome complements of the 6122/C17 progeny ranged from 18 to 38, with the majority of them in diploid and trisomic classes. All chromosomal groups from diploid to triploid, except 21 and 23 chromosomes, were produced. It is especially striking that only 1.2% of the microsporocytes had an 18-9 chromosome segregation without irregularities at anaphase I, yet 47.2% (67 out of 142 plants) of the progeny contained 18 or 27 chromosomes. Similarly, from a low percentage of 17-10 anaphase I segregation over 40% of progeny contained 19 or 26 chromosomes.

Apparently, the poor viability of those defective seeds with two or more extra chromosomes reduced the number of viable seedlings with intermediate chromosome numbers. Thus the chromosome numbers in the progeny of this triploid are in direct contrast to the expected chromosome numbers based on

the pattern of 6122 microsporocyte chromosomal segregation at anaphase I, and differ very much from random distribution. Deviation from a binomial curve and the presence of large numbers of diploids over triploids in the progeny could partially be due to elimination of supernumerary chromosomes, which caused corresponding increase of nuclei with lower chromosome numbers, during micro- and megasporogeneses. These indicated that gametes, thence zygotes, containing complete basic chromosome complements or the number of chromosomes approaching it were more feasible for survival.

Four of the 6122/C17 progeny plants were in tetraploidy, containing 34, 36, and 38 chromosomes, respectively. They could have developed from chromosome doubling of diploid zygotes, or from restitution triploid gametes pollinated by haploid pollen. Plants with chimeral sectors containing 18 and 36 or 19 and 38 chromosomes occurred occasionally among 6122/C17 progeny.

From the reciprocal C17 parents 78 progeny plants were grown. Among the 45 plants that had chromosome numbers checked 43 were diploid. Except two plants with 19 and 26 chromosomes, all other chromosome number classes up to 27 chromosomes were missing. This suggests that in addition to chromosome elimination the male gametophytes are less capable to transmit genetic disharmonies than that of the female, or aneuploid microspores are less competent and encounter greater selection pressure than megaspores during processes of fertilization. There could have been additional aneuploids among the 33 plants not cytologically examined.

Transmission of nematode resistance through 6122 as seed parent was 23.5% (35 out of 149 plants). Seven out of eight groups of 6122/C17 progeny with chromosome numbers from diploid to triploid contained nematode susceptible plants. The fact that only a smaller proportion of progeny and only two out of 12 27-chromosome plants were resistant indicated there could have been only one of the three genomes carrying resistance in 6122. If 6122 had two genomes bearing nematode resistance a diploid gamete containing any two genomes would have at least one dose of resistance. There is also the possibility that the relative ratios of resistance affects the strength of resistance, or that double reductions occurred that diverted diploid gametes to become susceptible. However, these possibilities would be unlikely because 10 of the 12 6122/C17 triploid progeny plants were susceptible to H. schachtii.

There are two possible explanations for the composition of only a single dose resistance. One is that the original diploid megaspore with nematode resistance was derived from a first division restitution nucleus. Such restitution nuclei could originate by the omission of the first meiotic division, or from the formation of second meiotic parallel spindles. The second explanation is that a resistant haploid megaspore of the diploid parent was fertilized by a susceptible diploid pollen. The probability of the latter would be less because diploid pollen usually occurred only at a rather low rate in diploid plants and this pollen is probably not competing very effectively with haploid ones in fertilization.

Inheritance of nematode resistance to progeny through the reciprocal parent C17 was lower than that of 6122, and the majority of C17/6122 progeny plants were of the 18-chromosome class. This could be due to pseudo-self fertility of the normally self-incompatible C17 seed parents, or due to the

resistant factor(s) causing detrimental effects on the resistance-bearing microspores. Self-compatibility of sugarbeet can be induced in some normally self-incompatible sugarbeets under certain environmental conditions, such as low temperature, high altitudes. The possibility of pollen contamination in this study was assumed to be minimal. If it occurred, however, it should have produced only susceptible plants with 18 chromosomes.

The average number of trivalent pairings in microsporocytes of 6122 was 7.24 III per cell at metaphase I. This ranged from 3 III to 9 III with 7 III the largest class followed by 8 III, 6 III, and 9 III classes. The triploid control had the same range of trivalent variations and an average of 7.71 III, but with relative frequencies in descending order of 8 III, 9 III, 7 III, and 6 III. The higher frequencies of univalent and bivalent formation in 6122 sporocytes than that of the triploid control probably caused by the presence of transposed genetic materials derived from Beta procumbens that were incorporated during the earlier generations of interspecific hybridization and backcrosses.

At anaphase I the 27 chromosomes of 6122 migrated to the poles and sorted themselves into two unequal groups in all possible numerical combinations. The 14-13 distribution was the most common type, which occurred at about 50% of 6122 cells, among those with intact chromosomes segregated to two nuclei. More than 19% of 6122 cells had meiotic abnormalities, whereas in the triploid control less than 3% occurred. These chromosomal abnormalities in the first meiotic division included up to six laggards, two bridges, and three fragments.

Meiotic chromosomal behavior of second prophase and metaphase of 6122 cells seemed to be normal. However, up to six micronuclei, single and double restitution nuclei, anaphase II bridges, and carry-over AI bridges were present following anaphase II. In comparison, plants of the triploid control had only occasional dicentric bridges, although the control contained about the same number of micronuclei as 6122. At tetrad stage, both 6122 and the triploid control produced one to seven sporads in the microsporocytes. Consequently, pollen grains of all these triploids were uneven in size and stainability. Based on appearance, more than one-half of the pollen grains of 6122 would be regarded as nonfunctional because they were inferior in size or stainability, or both.

Selection for Genotypes Resistant to Sugarbeet Nematode and Curly Top Virus from Dr. Savitsky's Progenies of Interspecific Hybrids

A total of 104 progeny plants that were derived from crosses of selected nematode-resistant sugarbeets were received from Dr. Savitsky. These plants were grown and pollinations made in the greenhouse. They were partially sterile and gave relatively poor seed set. The great majority of progeny seedlings from these greenhouse crosses so far tested segregated resistant and susceptible genotypes, indicating the heterozygosity and heterogeneity of the parental sources. Further crosses and progeny testings will be required in order to identify any genotypes that are true breeding for nematode resistance.

Beta trigyna Wald. et Kit. ($2n = 54$) has been considered highly resistant or immune to curly top virus. Forty B. trigyna x B. vulgaris B_1 progeny plants were obtained from her. Those plants contained triploid level chromosome numbers and were highly sterile. They were pollinated by diploid sugarbeets. To screen for curly top resistance, young seedlings at the four-leaf stage were inoculated with highly virulent Logan strain curly top virus. Six to eight leafhoppers, Circulifer tenellus (Baker), that had acquired curly top virus from infected host plants were caged on each plant as vectors, feeding for a week. Up to the present, all B_2 progeny plants that have finished testing showed positive curly top symptoms, i.e., they were susceptible.

Meanwhile, a burlap sack of the harvested B. vulgaris (4x)/B. corolliflora (4x) F_1 x B. vulgaris (2x) plant material also was received from her. However, only a small amount of B_1 seed was able to be threshed from all the material and 43 seedlings were established. Those seedlings were of triploidy. After inoculation of viruliferous leafhoppers, five plants showed negative symptoms to curly top. The selected plants were pollinated by diploid sugarbeets in the greenhouse. Because of the unbalanced chromosomal composition all of the five plants were sterile. Seed setting was extremely poor. Three seeds germinated but only one seedling established for testing. That seedling was found susceptible.

These results indicated that introduction of curly top resistance through the B_1 materials that Dr. Savitsky provided is unlikely. B. trigyna itself probably lacks curly top resistance. Consequently, a new attempt to conduct hybrid crosses between sugarbeet and B. corolliflora is being initiated for the coming season.

INTERSPECIFIC HYBRIDIZATION

VULGARIS-PROCUMBENS HYBRIDS

Helen Savitsky

Production of homozygous nematode-resistant lines which transfer resistance to all their offspring is necessary for incorporation of nematode resistance into commercial sugarbeet varieties. Two homozygous nematode-resistant plants were obtained in 1980. They were pollinated by heterozygous nematode-resistant plants and transferred resistance to 100% of their F_1 offspring. The heterozygous pollinator used in reciprocal crosses with first and second homozygous plants transmitted resistance to 88% and to 100% correspondingly.

Two methods are applied for production of homozygous nematode-resistant lines: (1) Intercrosses of F_1 resistant hybrids to increase and to maintain the group of homozygous and heterozygous plants which transmit resistance to all offspring. New homozygous resistant plants may be selected from this group. (2) Pollination of resistant F_1 plants by nematode susceptible plants and hybridization of those F_1 plants which transmitted resistance to 100% of their offspring, or to the offspring of susceptible plants.

Investigation of resistance transmission from F_1 to F_2 nematode-resistant hybrids

In 1981 F_1 plants derived from transmission of nematode resistance from the first and second homozygous resistant plants to 100% of their offspring were intercrossed and the F_2 plants in their progenies were tested for resistance. The other F_1 plants from the similar hybrids were crossed with nematode susceptible beets and their F_2 progenies were also tested for resistance.

In eight F_2 progenies, derived from intercrossed F_1 plants from the first homozygous plant, 133 plants were tested for resistance. In four of these progenies all F_2 plants were resistant. In the other four F_2 progenies the majority of plants were resistant, but few susceptible plants lowered the resistance of these progenies to 83.3%, 93.3%, and 96.9%. In F_2 progenies of the second homozygous plant 63 F_2 plants were tested for resistance. All were resistant. The second homozygous plant showed a higher rate of resistance transmission. Resistance was transmitted to 100% of F_1 and of F_2 offspring.

The resistant F_2 hybrids of the first and of the second homozygous plants which derived from transmission of resistance to 100% of F_1 and of F_2 offspring are being intercrossed and their F_3 seed will be released to sugar companies.

Because of the absence of support from the Beet Sugar Development Foundation, the hybrids production and investigation were greatly reduced. The hybrid materials were given to Dr. Yu and to Dr. McFarlane. Dr. Yu received all hybrids between *B. vulgaris* and *B. lomatogona* and *B. vulgaris* x *B. trigyna* hybrids. Both of these hybrids were produced for transmission

of curly top resistance from wild species into sugarbeet. Dr. Yu also received more than 100 F_1 nematode-resistant plants of B. vulgaris x B. procumbens crosses derived from transmission of resistance from homozygous plant to 100% of the F_1 offspring.

Dr. McFarlane tested for nematode resistance the seed of 90 plants which I obtained from pollination of nematode-resistant F_1 plants by nematode susceptible beet. This test detected that 10 F_1 resistant hybrids were homozygous and transmitted resistance to all offspring of susceptible beets. Seed of these F_1 plants were resistant heterozygotes. They were given to Dr. McFarlane for his field test of nematode resistant plants.

I saved the 10 F_1 homozygous resistant plants and intercrossed them for the production of a homozygous nematode resistant line. Unfortunately these plants set some seed and died (because they were used a second time for seed production). Seed obtained from these homozygous nematode resistant plants were planted for propagation of homozygous nematode resistant material. The plants grown from them will be intercrossed and their seed will be released to sugar companies. The homozygous nematode-resistant plants are new genotypes which never before existed. They must be studied and selected. Observation of the first obtained homozygous resistant plants revealed that their anthers and pollen are poorly developed which caused different degrees of sterility in individual plants. The same concerned some plants in F_1 and F_2 hybrids derived from transmission of resistance to 100% of offspring. Such hybrids contain some homozygous resistant plants. Selection of plants showing higher fertility should eliminate this deficiency.

Breeding for Resistance to the Sugarbeet Nematode

J. S. McFarlane, Helen Savitsky, and Arnold E. Steele

In 1978, additional Federal funds became available for nematode resistance breeding. An accelerated program was started with the following objectives: 1) Develop a rapid greenhouse technique for testing the resistance of thousands of plants; 2) Selection of lines with high transmission rates; and 3) Evaluation of the selections in the field.

Selection and Testing Methods

Greenhouse selection technique. Soil was collected from newly harvested fields that were known to be heavily infested with the sugarbeet nematode. When attempts were made to test seedlings directly in this infested soil, the results were variable. The plants were frequently attacked by damping-off organisms and they either died or were severely stunted. The soil usually came from fields that had been treated with one or more herbicides and even minute residues caused abnormal plant growth in greenhouse tests. Nematode cyst populations also varied greatly in the field collected soil and this influenced the accuracy of the tests.

To overcome these problems, nematode cysts were extracted from soil and treated with a fungicide before they were used to evaluate the plant populations for nematode resistance. To extract the cysts, an automated cyst flotation apparatus was designed and constructed. This separator was patterned after a flotation apparatus developed at the Rothamsted Experimental Station in England. Through the use of this apparatus, it was possible to recover more than 90% of the cysts from field soil.

The flotation apparatus provided a mixture of nematode cysts, small pieces of plant debris, and fine sand. To control damping-off organisms the mixture was treated for 4-6 hours in a fenaminosulf (Dexon) solution at the rate of ½ teaspon per gallon of water. After determining the inoculum required to heavily infest susceptible sugarbeet, a measured quantity of cysts was added to soil and thoroughly mixed in a small concrete mixer. The inoculum contained from 15-30 cysts per 100 cc of soil. Testing was done in either aluminum planting bands or in 8 oz. styrofoam cups.

The bands or styrofoam cups were filled with the nematode inoculated soil and 10-day old sugarbeet seedlings were transplanted in the soil. The plants were grown in the bands or cups for 7-8 weeks or until white females appeared on the roots. The plants were then removed from the bands or cups with soil intact and examined for the presence of nematodes. Following the greenhouse test, the selected resistant plants were transplanted, allowed to become re-established in the greenhouse, and placed in the coldroom for thermal induction. After 4 months of thermal induction at a temperature of 40-45° F., the plants were removed and seed was produced.

Field testing technique: Selections that had been made for nematode resistance in the greenhouse were tested in the field. This was done by comparing the performance of selected plants in a heavily nematode infested area with that in a fumigated area. A test area was selected that had grown beets for the past 3 years and was known to be nematode infested. The test

area was divided into two parts and one-half was treated with dichloropropene at the rate of 25 gals. per acre. To insure a uniform infestation, heavily nematode infested soil was drilled into beds in the nonfumigated area and a susceptible sugarbeet cultivar planted in the inoculated bed on March 17. The plants were removed June 15 and the beds tilled. Soil tests indicated that a high population of sugarbeet nematode occurred throughout the test area. A second application of nematode infested soil was drilled into the tilled beds and test material was planted June 25. The plots consisted of a single row, 10 ft. long. Every third row was planted to a susceptible check.

Results

Greenhouse tests: More than 24,000 plants from 350 families developed by Savitsky from interspecific hybrids between sugarbeet and Beta procumbens were tested for nematode resistance in the greenhouse. The level of resistance varied widely with most families falling in the 20-60% range. Resistant plants from the most promising of these 350 families were crossed in pairs or backcrossed to susceptible sugarbeet lines. The progenies of these hybrids were tested and resistant segregates again crossed in pairs or backcrossed to susceptible sugarbeets. The same selection and hybridization process was repeated with progenies of these crosses. A portion of the selections was crossed with self-fertile lines and selections made in the selfed generations. Results with the successive selections in both the self-sterile and self-fertile lines are given in Table 1. When resistant selections from the Savitsky material were crossed in pairs, the 201 progenies that resulted showed a wide range in resistance. Most progenies (79%) fell in the 26-75% range and only 4% of the progenies had a resistance rating above 75%. When the resistant selections from the F_1 crosses were again crossed in pairs, their 265 F_2 progenies showed improved resistance. Seventy-six percent of the progenies were in the 50-75% range and 14% rated 75% or higher in resistance with 8% of the progenies showing no nematodes on any of the test plants. Plants from these highly resistant lines were again crossed in pairs and their F_3 progenies showed further improvements in resistance. Of 138 progenies, 28 showed no nematode development. These highly resistant progenies were closely related and had originated from only four of the original Savitsky populations.

The progenies of resistant selections from the Savitsky lines x susceptible sugarbeet were more nematode susceptible than were the progenies of resistant x resistant crosses. When resistant selections from resistant x resistant crosses were backcrossed to susceptible sugarbeet, the progenies also tended to be susceptible. However, when resistant selections from the F_2 selections were backcrossed to sugarbeet, the progenies showed a marked improvement in resistance. The resistant F_2 parents had been derived from progenies with 100% resistance and transmitted resistance to a higher proportion of the offspring.

Table 1. Progress in the improvement of resistance to nematode development in successive crosses and selfs of greenhouse selections derived from sugarbeet x Beta procumbens hybrids.

Generation	Progenies Tested	Total Plants Tested	Distribution of hybrids and selfs into four levels of resistance 1/			
			1	2	3	4
	No.	No.	%	%	%	%
F_1 (Res. x res.)	201	9,110	17	46	33	4
F_2 (Sel. from F_1)	265	12,650	10	52	24	14
F_3 (Sel. from F_2)	138	9,350	3	30	30	37
Res. x susc.	210	6,870	40	44	14	2
Res. F_1 x susc.	110	3,090	45	48	5	2
Res. F_2 x susc.	90	4,090	28	43	4	23
S_1 (Res. x susc. Sf)	330	14,060	20	49	22	9
S_2 (Sel. from S_1)	155	5,180	39	40	15	6

1/ Each hybrid or selfed population was assigned to a level based on the average percent of resistant plants. Level 1 = 0-25% resistant, level 2 = 26-50% resistant, level 3 = 51-75% resistant, level 4 = 76-100% resistant.

Field tests: A field test was made in 1981 to determine the performance of 91 lines, with various levels of resistance to nematode development, when grown in a heavily nematode infested area compared with the same lines grown in an adjacent area that had been fumigated with dichloropropene. The fumigant provided good nematode control and striking differences in performance occurred between the infested and the fumigated areas. Results with the 91 lines are given in Table 2. Performance was consistently superior in the fumigated area for all lines regardless of the level of greenhouse resistance.

A reduction in vigor became evident in the nematode infested area soon after emergence. Stunting became more pronounced during the first two months of growth but the severity varied among lines. Little relationship was observed between the degree of stunting and greenhouse resistance. Losses from seedling diseases occurred in both the infested and fumigated areas but were more severe in the infested area. The differences among lines in the two areas varied greatly and was less consistent than with stunting. The loss of plants from seedling disease was not associated with the level of greenhouse resistance.

Root yields for all lines were lower in the nematode infested area. Loss of plants from seedling diseases caused irregular stands so comparisons between areas were made on the average root weight basis. A wide range in yield reduction caused by nematode damage occurred among the lines tested but losses were not associated with the level of greenhouse resistance. Both

Table 2. Performance of lines with differing levels of resistance to nematode development when grown in a field area heavily infested with sugarbeet nematode compared with the same selections grown in an adjacent area fumigated for nematode control. Planted at Salinas, California, June 25, 1981 and harvested November 4-9, 1981.

Type of Material	Resistance[1]	Vigor[2]		Dead Plants		Ave. Root Wt.		Yield Loss	Sucrose		Sucrose Loss
		NF[3]	NI	NF	NI	NF	NI		NF	NI	
	%	Grade	Grade	No.	No.	Grams	Grams	%	%	%	Pct. Pts.
Res. x susc.	100	5	6	3	4	225	140	38	13.3	12.7	0.6
Res. x susc.	100	4	9	3	16	435	30	93	12.0	9.7	2.3
Res. x susc.	100	3	6	1	3	200	155	23	12.2	11.7	0.5
Res. x susc.	100	2	5	1	7	150	120	20	11.0	11.0	0.0
Res. x susc.	100	4	7	0	0	315	255	19	12.5	10.7	1.8
Res. x susc.	100	5	7	2	7	180	115	36	11.4	8.0	3.4
Res. inbred	100	4	7	2	1	615	75	88	11.1	11.9	+0.8
Res. inbred	94	4	7	1	3	360	245	32	12.1	9.4	2.7
Res. inbred	90	4	7	6	8	155	105	32	10.4	7.7	2.7
Res. x susc.	89	3	6	4	6	165	100	39	10.3	10.0	0.3
Res. x susc.	89	6	7	5	14	135	85	37	10.0	10.2	+0.2
Res. x susc.	89	4	6	8	6	380	285	25	9.4	10.7	+1.3
Res. x susc.	87	5	7	6	5	280	175	38	10.4	9.5	0.9
Res. x res.	86	4	7	0	4	250	55	78	11.9	10.8	1.1
Res. inbred	86	4	7	2	9	170	65	62	6.9	9.7	+2.8
Res. inbred	86	3	8	3	5	520	45	91	12.1	10.0	2.1
Res. x susc.	85	4	7	0	1	655	180	73	10.5	13.9	+3.4
Res. x res.	84	2	7	0	4	305	145	52	12.1	8.8	4.1
Res. inbred	83	5	8	0	9	175	25	86	7.9	5.7	2.2
Res. inbred	80	3	8	2	9	365	65	82	10.2	8.2	2.0

1/ Percent of plants that developed no nematodes in greenhouse test.

2/ Plots graded for vigor on scale of 0 to 9. 0 = excellent vigor, 9 = extremely low vigor to dead plants.

3/ NF = Soil fumigated with dichloropropene for nematode control. NI = Nematode infested soil.

Table 2. Continued.

Type of Material	Resistance[1]	Vigor[2]		Dead Plants		Ave. Root Wt.		Yield Loss	Sucrose		Sucrose Loss
		NF[3]	NI	NF	NI	NF	NI		NF	NI	
	%	Grade	Grade	No.	No.	Grams	Grams	%	%	%	Pct. Pts.
Res. x res.	80	4	7	0	2	480	190	60	6.6	7.1	+0.5
Res. inbred	79	4	7	1	6	380	210	45	11.1	7.6	3.5
Res. x res.	79	4	7	1	5	385	145	62	6.7	8.2	+1.5
Res. x susc.	78	5	7	9	4	180	105	42	11.4	10.8	0.6
Res. x susc.	78	3	8	1	6	295	30	90	10.5	7.8	2.7
Res. x res.	77	4	6	3	7	410	225	45	10.2	8.9	1.3
Res. inbred	77	5	8	1	3	515	20	96	9.0	5.1	3.9
Res. inbred	77	5	9	2	11	455	185	59	11.3	10.7	0.6
Res. x res.	75	3	7	2	5	250	65	74	13.5	10.1	3.4
Res. x susc.	75	1	7	4	4	440	140	68	12.4	9.7	2.7
Res. inbred	74	5	8	1	10	250	190	24	-	-	-
Res. x res.	73	4	7	1	14	300	100	67	10.8	10.3	0.5
Susc. x res.	72	1	6	1	2	350	165	53	13.6	10.2	3.4
Res. x res.	71	3	6	2	0	680	250	63	11.4	11.2	0.2
Res. x susc.	70	3	7	3	9	225	100	56	11.7	8.5	3.2
Res. x res.	70	3	8	1	6	515	110	79	12.4	7.5	4.9
Susc. x res.	70	1	7	0	10	385	120	69	12.5	8.4	4.1
Res. x res.	70	3	7	4	4	475	160	66	9.2	7.6	1.6
Res. inbred	70	4	7	3	0	460	75	84	13.0	9.7	3.3
Res. inbred	70	3	8	2	4	330	35	89	11.5	8.1	3.4
Res. inbred	69	4	8	3	3	285	60	79	9.6	8.7	0.9
Res. x susc.	67	1	6	3	1	355	230	35	14.5	12.5	2.0
Res. x res.	67	3	7	0	10	380	165	57	13.2	10.6	2.6
Res. x susc.	67	2	7	6	3	610	120	80	11.5	10.8	0.7
Res. x res.	67	5	7	6	5	215	155	28	11.6	11.5	0.1

Table 2. Continued.

Type of Material	Resistance[1]	Vigor[2]		Dead Plants		Ave. Root Wt.		Yield Loss	Sucrose		Sucrose Loss
		NF[3]	NI	NF	Nl	NF	NI		NF	NI	
	%	Grade	Grade	No.	No.	Grams	Grams	%	%	%	Pct. Pts.
Res. x res.	66	4	7	2	1	380	115	70	10.9	9.9	1.0
Res. inbred	66	4	8	4	12	485	220	55	12.3	11.9	0.4
Res. x res.	65	3	8	3	8	320	45	86	12.3	11.5	0.8
Res. x res.	65	4	7	0	2	475	250	47	8.8	7.0	1.8
Res. x res.	64	3	6	5	3	400	225	44	12.9	10.2	2.7
Res. x res.	64	2	6	1	1	255	110	57	13.1	10.0	3.1
Res. x susc.	63	1	5	1	0	760	265	65	12.2	11.1	1.1
Res. inbred	63	3	7	0	6	390	120	69	7.6	6.2	1.4
Res. inbred	63	4	7	2	1	250	75	70	11.0	7.0	4.0
Res. x susc.	62	1	6	0	5	295	135	54	13.3	11.6	1.7
Res. x susc.	62	2	6	0	1	250	150	40	10.3	9.8	0.5
Res. x res.	62	4	8	1	9	230	35	85	11.2	12.7	+1.5
Res. x res.	62	3	7	1	3	230	110	52	13.3	10.1	3.2
Res. inbred	62	3	8	0	6	325	140	57	9.1	11.1	+2.0
Res. x res.	61	3	8	3	0	235	35	85	11.5	10.0	1.5
Res. x res.	61	6	7	2	7	190	155	18	11.0	12.2	+1.2
Res. x susc.	61	3	7	1	6	560	200	64	11.5	9.3	2.2
Res. inbred	61	5	8	3	7	205	55	73	9.0	6.1	2.9
Res. inbred	60	2	8	2	4	425	50	88	8.8	4.5	4.3
Susc. x res.	60	2	7	3	6	285	205	28	10.9	10.1	0.8
Res. x res.	60	4	7	2	4	385	220	43	6.4	7.1	+0.7
Res. x res.	57	3	7	4	4	480	190	60	11.9	9.6	2.3
Res. x res.	54	6	7	2	9	195	115	41	13.2	10.7	2.5
Res. x res.	52	2	8	0	4	640	215	66	11.5	9.1	2.4
Res. x susc.	50	3	6	2	5	340	150	56	12.8	10.2	2.6

Table 2. Continued.

Type of Material	Resistance[1]	Vigor[2] NF[3]	Vigor[2] NI	Dead Plants NF	Dead Plants NI	Ave. Root Wt. NF	Ave. Root Wt. NI	Yield Loss	Sucrose NF	Sucrose NI	Sucrose Loss
	%	Grade	Grade	No.	No.	Grams	Grams	%	%	%	Pct. Pts.
Res. inbred	50	3	7	0	3	725	195	73	10.6	10.4	0.2
Res. x res.	46	3	7	1	1	410	190	54	8.3	10.4	+2.1
Res. x susc.	44	2	7	4	3	490	120	76	13.3	9.2	4.1
Res. x susc.	44	1	6	1	4	330	205	38	13.9	12.4	1.5
Susc. x res.	41	3	6	4	5	665	200	70	12.4	11.2	1.2
Res. x susc.	33	1	6	7	4	310	120	61	8.3	8.4	+0.1
Res. x susc.	30	2	8	4	14	275	65	76	12.9	10.8	2.1
Res. x susc.	29	3	7	2	12	295	130	56	13.5	5.2	8.3
Res. x res.	26	4	7	0	3	325	140	57	12.7	11.5	1.2
Res. x susc.	25	3	6	0	0	165	125	24	12.1	10.1	2.0
Res. x susc.	21	3	7	2	12	310	100	68	11.9	7.3	4.6
Res. x susc.	20	2	5	1	2	405	170	58	11.7	10.3	1.4
Res. x susc.	17	2	5	1	0	360	225	38	12.6	11.8	0.8
Res. x susc.	13	2	4	0	2	470	255	46	14.4	11.6	2.8
Res. x susc.	11	2	6	0	3	285	130	54	10.7	10.2	0.5
Res. x susc.	10	3	7	3	7	360	90	75	12.3	11.0	1.3
Res. x susc.	0	3	6	3	4	450	170	62	11.8	11.1	0.7
Res. x susc.	0	2	7	5	12	485	140	71	14.0	10.6	3.4
Susc. inbred	0	3	8	10	5	620	70	89	12.6	8.3	4.3
Wilt tol. sel.	0	1	6	2	5	370	210	43	9.1	9.1	0.0
Susc. check	0	2	6	-	-	415	195	53	10.0	9.9	0.1

root size and numbers of roots were small, especially in the nematode infested area and this caused problems in obtaining accurate sucrose determinations. A wide range in sucrose percentages was observed among lines and tended to be lower in the infested area. The loss in sucrose from nematode damage was not affected by the level of greenhouse resistance (Table 3).

Table 3. Summary of the performance of 91 sugarbeet lines with differing levels of resistance to nematode development when grown in a field area heavily infested with sugarbeet nematodes compared with the same lines grown in a fumigated area.

Resistance[1/]	Lines	Ave. Root Wt. NF[2/]	Ave. Root Wt. NI	Yield Loss	Sucrose NF	Sucrose NI	Sucrose Loss
%	No.	Grams	Grams	%	%	%	Pct. Points
0-25	12	393	193	51	11.1	9.8	1.3
26-50	10	391	155	60	11.8	10.1	1.7
51-75	41	367	144	61	11.4	9.3	2.1
76-100	28	307	130	58	10.5	9.5	1.0

1/ Percent of plants that developed no nematodes in greenhouse test.

2/ NF = Soil fumigated with dichloropropene for nematode control.
NI = Nematode infested soil.

Nematode counts were made in field soil collected November 2 from around the root systems of plants in the nematode infested area. Soil was collected from around plants in three lines that were 100% resistant to nematode development in the greenhouse tests, from one line that had intermediate resistance, and from three plots of the susceptible US H11 cultivar. The distribution of the cysts and white females is shown in Table 4. The large empty cyst counts indicate that the nematode population had been high in the infested area. The viable cyst count was relatively low in soil from the 100% resistant plants, a little higher in the soil from the line with intermediate resistance, and tended to be high in soil from the susceptible check. The viable cysts contained both eggs and larvae and were either present in the soil when the test was started or were produced during the course of the test. Counts of full cysts and white females were very low in soil from the resistant and moderately resistant lines and high in soil from the US H11 plants. Most of the full cysts and all the white females were produced during the 1981 growing season.

Table 4. Sugarbeet nematode populations in field soil following the growth of breeding lines and cultivars that differ in their resistance to nematode development.

Line or Cultivar	Level of Resistance[1/]	Plants	Nematode population per plant			
			Empty Cysts	Viable Cysts	Full Cysts	White Females
	%	No.	No.	No.	No.	No.
S12	100	3	375	18	1	0
S15	100	2	243	27	2	0
S29	100	3	453	34	0	0
N142	60	3	479	45	2	4
US H11	0	2	389	137	43	20
US H11	0	2	471	88	20	18
US H11	0	2	189	43	17	9

1/ Percent of plants that developed no nematodes in greenhouse tests.

Summary

A rapid greenhouse technique was developed for testing segregating sugarbeet populations for nematode resistance. Through the use of this technique a technician and one helper were able to test more than 88,000 plants in a 2½ year period. Large numbers of tests were required before lines with high transmission rates were obtained. From 350 segregating families developed by Savitsky, only four gave rise to lines that eventually transmitted resistance to 100% of their offspring. Several F_3 lines originating from these four families were found to be 100% resistant. Sterility was a problem in lines with 100% resistance and seed set tended to be low. Field tests to determine the performance of greenhouse selections when grown in heavily infested soil showed that resistance to nematode development had little influence on field losses from nematodes. Larvae invaded the roots of resistant plants and caused damage similar to that found on susceptible plants but were unable to complete their development. Viable nematode populations were lower in soil removed from the root zones of resistant plants than in that adjacent to susceptible plants. Cultivars resistant to nematode development may be of greatest value as a trap crop.

BOLTING AND VARIETY TRIALS, SALINAS, CALIFORNIA, 1980-81

Location: USDA-ARS Agricultural Research Station

Soil type: Sandy loam (Chualar series)

Previous crops: 1980-81 Sugarbeet test areas, Spence Field:
Block 1 - south 8.4 acres, fallow 1978-1980; sugarbeet trials, 1977.
Block 2 - south 9.8 acres, fallow 1978-1980; sugarbeet trials, 1977.

Fertilizer and pesticides used: Preplant: Dolomite (equivalent to 105% $CaCO_3$) was broadcast at rates of 535 lbs/A and disced in about 6" deep. Both 1980-81 test areas had 395 to 410 lbs. 5:20:10 applied broadcast and chiseled in prior to the chiseling in of 18 gal/A Telone 2 (for control of possible sugarbeet nematode infestation) during October 1980. Test areas were listed in November 1980 and prior to seeding, about 330 lbs/A ammonium sulfate was Bye Hoe incorporated into a 9-inch band on the bed tops.

Supplemental nitrogen: Two or three applications, as sidedressed ammonium sulfate or by sprinkler irrigation system as 32% nitrogen in a liquid formulation.

Total fertilization (lbs/A):

N	P_2O_5	K_2O
277	80	40

Summary: 1980-81 Tests at Salinas (Spence Field):

Test No.	Sowing Date 1980-1981	Thinning Date 1981	Test Entries No.	Reps No.	Plot Row No.	Plot Row Lgth. Ft.	Harvest Date 1981	Test Design
181	12/19	2/2-6	112	2	1	30	Obs. Test	RCB
281	12/19	"	16	2	1	30	" "	RCB
381-1	12/18	"	20	4	1	30	11/9	RCB
381-2	3/11	4/9-15	20	4	1	37	11/5	RCB
481	12/18	2/2-6	16	8	2	30	9/16-18	RCB*1/
581	12/18	"	16	8	2	30	9/21-24	RCB*
681	12/19	"	16	8	2	30	9/21-24	RCB*
781	12/18	"	8	8	2	30	9/28-29	RCB
881	12/18	"	8	8	2	30	9/28-29	RCB
981	12/19	"	8	8	2	30	10/13	RCB
1081-1	12/19	"	112+16	1	1	30	10/13-14	Rep I
1081-2	2/23	4/1-6	112+16	1	1	30	10/14-15	Rep II
1081-3	3/11	4/9-15	112+16	1	1	37	10/15	Rep III
1181	2/23	4/1-6	16	8	2	30	9/29-30	RCB*
1281-1	2/23	"	8	8	2	30	10/1	RCB
1281-2	2/23	"	8	8	2	30	---	RCB
1381	2/23	"	16	8	2	30	10/8-9	RCB*
1481	2/23	"	8	8	1	30	10/5-6	SB(LS)2/
1581	2/26	"	8	8	2	30	10/6&8	SB(LS)

Test No.	Sowing Date 1980-1981	Thinning Date 1981	Test Entries No.	Reps No.	Plot Row No.	Plot Row Lgth. Ft.	Harvest Date 1981	Test Design
1681(10-C)	3/12	4/9-15	16	6	4	22	10/5-6	RCB
1781	3/12	"	8	8	1	37	10/19	SB(LS)
1881	3/12	"	8	8	1	37	10/20	SB(LS)
1981	3/17	"	8	8	1	37	10/26	SB(LS)
2081	3/12	"	8	8	1	37	10/22	SB(LS)
2181	3/17	"	16	8	1	37	10/26	SB
2281	3/12	"	8	8	1	37	10/21	SB(LS)
2381-1	5/13	6/9-11	24	4	1	24	Obs. Test	RCB
2381-2	5/13	"	241	2	1	24	Obs. Test	RCB

1/ RCB* = Each variety occurs once in each pair of rows.
2/ SB(LS) = Split Block with varieties in Latin square.

Inoculation dates (1981): Tests 1781 through 2281: May 20 with a combination of BYV-BWYV. Tests 2381-1 and 2381-2: July 23, 1981 with a suspension of Erwinia isolates.

Irrigation: By either furrow or sprinkler system as required at 7-14 day intervals except during stand establishment when frequent light sprinkler irrigations were used.

Herbicide use: Pyramin W, at rates of approximately 4 lbs/A, was sprayed post plant and watered in with 1/2 to 3/4 inch sprinkler irrigation.

Diseases and insects: Natural virus yellows infection was light throughout throughout tests seeded between December 18, 1980 and March 17, 1981 (Tests 181 through 1581, Block 1, and Tests 1681 through 2281, Block 2).

Inoculated BYV-BWYV Tests 1781 through 2281 were sprayed with approximately 3 pints/A Meta Systox R on May 22, 1981 for control of BYV-BWYV vector and Tests 381-2 and 1681 for control of natural aphid flights.

All Tests, inoculated and non-inoculated, were sprayed with Meta Systox R by aircraft for aphid control on July 10, 1981 with 2-3 pints/A.

Powdery mildew infection was moderately severe in 1981 where it was not controlled and appeared first (mid-June) in the earliest seeded tests. The degree of control, with the application of sulfur appeared to be more variable in 1981 than that observed in previous years. One to four spray applications of wettable sulfur at rates of 10 to 15 lbs/A, on designated test areas, were made on June 24, July 10 and 31, August 6 and 31, 1981. Some differential responses in yield probably occurred due to PM infection particularly in test areas in Block 2.

Downy mildew infection was not a significant disease problem in 1981.

Natural infection of Erwinia soft rot was relatively light in susceptible lines and had minimum effect on yield in 1981.

Sugarbeet nematode infestation was not observed in 1981 test plot areas, however, as a precaution, test areas were fumigated with Telone 2.

Sugar analysis: Determined from two samples per plot of approximately 10 roots each or 25-40 lbs. of roots at the sugar analytical laboratory, U.S. Agricultural Research Station, Salinas, California.

Remarks: Test results should be generally reliable for 1981.

The assistance of Dr. F. J. Hills and Ms. Patricia Thomas, University of California at Davis, in the analysis of test data is gratefully acknowledged.

TEST 181. OBSERVATION PLOT, SALINAS, CALIFORNIA, 1981

112 entries with 2 replications
1-row plots, 30 ft. long — Planted: December 19, 1980

Variety	Description	Stand Count	Bolting 1/ 8/31/81	P.M. Scores 7/31	9/10
		Number	%		
OPEN-POLLINATED					
917	Inc. 417 (C17)	89	0.0	6.5	7.5
E937	Inc. E837	88	0.0	6.5	6.5
E037	Inc. E937	86	0.0	5.5	7.0
F80-37	Inc. E937 (C37)	92	0.0	6.5	7.5
F78-36	Inc. F77-36 (78087)	87	0.0	6.5	7.0
F79-36	Inc. C36 (79377)	85	0.0	6.5	7.5
F79-31	Inc. C31E2 (79427)	83	3.6	4.5	4.5
Y831E (C31E2)	YRS Y631E	85	0.0	5.0	3.0
Y931E	YR-ER Y631E	92	1.1	4.0	3.5
Y031	NB Y831E	76	0.0	4.5	3.0
Y031P	PMR 8237, 8, 9	78	2.6	3.0	1.0
Y031	Inc. F79-31	78	1.3	4.0	2.0
Y939	Inc. Y839	80	3.8	3.5	2.5
Y039	NB Y839	76	3.9	3.0	2.5
Y940	Inc. Y840	83	2.4	5.0	5.5
Y040	NB Y840	89	2.2	5.5	6.0
Y741	Inc. Y641	84	4.8	4.0	6.5
Y941	Inc. Y841	83	15.7	2.5	5.0
Y041	NB Y841	86	2.3	2.5	5.0
Y041P	PMR 8235, 6	83	1.2	2.0	2.5
Y746	Inc. Y646	83	0.0	3.5	5.0
Y946	Inc. Y846	86	0.0	3.0	5.0
Y046	NB Y846	86	0.0	2.5	4.5
Y046P	PMR 8230, 1, 2, 4	86	0.0	3.0	3.5
Y942	Inc. Y842	78	6.4	5.0	4.5
Y042 (C42)	YR-ER Y842	76	0.0	3.0	2.5
Y047	Inc. Y947	77	5.2	4.0	7.0
Y048	Inc. Y948	79	1.3	4.0	5.5
Y049	Inc. Y949Rr	87	0.0	4.5	7.0
Y050	Inc. Y950Rr	76	3.9	3.5	5.5
Y051	Inc. Y951Rr, Y953Rr	69	0.0	4.0	6.5
Y052	Inc. Y952Rr	87	8.0	5.0	7.0
Y023	Inc. Y923	69	7.2	4.0	4.0
Y026	Inc. Y926	81	8.6	4.0	6.5
Y030	Inc. Y930	80	1.3	6.5	8.0
964	Inc. 364 (C64)	77	0.0	4.0	4.5
Y906	Inc. R&G OT-42	91	24.2	5.5	7.0
968	Inc. 468 (US 75)	77	5.2	5.5	7.0
Y009	Inc. US 22/3	79	68.4	6.0	8.0
SP6822-0	Lot 6519	89	75.3	3.5	8.0

1/ Test planted too late and winter too mild to get high levels of bolting.

TEST 181. OBSERVATION PLOT, SALINAS, CALIFORNIA, 1981

Variety	Description	Stand Count	Bolting 8/31/81	P.M. Scores 7/31	P.M. Scores 9/10
		Number	%		
F79-36	Inc. C36 (79377)	82	0.0	6.0	7.0
40619L	Betaseed Hybrid	79	29.1	4.0	6.5
PM-2	22-7, 8	80	0.0	2.5	5.0
PM-3	90-1, 20, 28	77	0.0	3.0	6.5
PM-4	22-3B	83	0.0	2.5	7.0
PM-5	435-8H-2-1	85	1.2	3.0	5.5
PM-6	22-9	86	0.0	3.0	7.0
F79-36	Inc. C36 (79377)	84	0.0	5.0	8.0
PM-1	22-9, 13, 16	79	0.0	3.0	7.5
PM-7	22-20	81	1.2	3.0	6.5
PM-8	435-8A-1-2	82	2.4	2.5	6.0
PM-9	22-4	79	0.0	2.0	5.0
PM-10	90-28	79	0.0	3.5	5.5
F79-36	Inc. C36 (79377)	78	0.0	5.0	7.5
SELF-FERTILE, RANDOM MATING					
0740	9740aa x A	83	2.4	3.0	6.0
0740H0	8740H0 x 9740	87	3.4	3.5	7.0
0741	9741aa x A	83	1.2	3.5	6.5
0741H0	8741H0 x 9741	79	7.6	4.5	8.0
0742	9742aa x A	79	15.2	4.0	8.0
0742H0	8742H0 x 9742	83	7.2	4.5	8.0
0744A	Inc. 9744	81	3.7	5.0	7.5
0744H0	8744H0 x 9744	81	2.5	6.5	8.0
0745	9745aa x A	74	4.1	4.0	7.5
0745H0	8745H0 x 9745	80	5.0	5.0	8.0
7755	6755aa x A	88	3.4	3.5	4.0
9755	YR-ER 7755B	85	7.1	3.0	1.5
0755	9755aa x A	81	9.9	2.5	3.0
0755H0	8755H0 x 9755	86	15.1	2.0	2.5
0755A	Inc. T-0-Sel. 9755	78	5.1	2.5	2.5
0755aa	T-0-9755aa x A	83	6.0	2.5	2.0
0755H0	8755H0 x T-0-9755	85	2.4	3.0	4.5
8755H0	7755H0 x 7755B	84	4.8	2.5	4.5
0755-29A	Inc. 9755-29	79	0.0	5.0	3.5
0755-29 (C301)	9755-29aa x A	80	0.0	3.5	3.0
0755-29H0	8755H0 x 9755-29	82	1.2	3.5	7.0
0755-29	Inc. 9755-29A-	80	1.3	4.0	1.5
0796-1	ER-YR 8796-1	81	0.0	7.0	8.0
0796-2	ER-YR 8796-2	86	1.2	4.5	7.0
0792	ER 8792	87	0.0	2.5	1.0
0793	ER 8793	87	4.6	4.5	8.0
0794	ER 8794	87	1.1	4.5	8.0
0795	ER 8795	78	3.8	6.5	7.5
0798	ER 8798	72	5.6	2.5	4.5
0725	9751-1, ..., -14mm⊗	83	6.0	3.0	4.5
0747	ER-YR 7747	90	1.1	5.5	7.0
0748	ER-YR 7748	95	0.0	6.0	8.0

TEST 181. OBSERVATION PLOT, SALINAS, CALIFORNIA, 1981

Variety	Description	Stand Count	Bolting 8/31/81	P.M. Scores 7/31	9/10
		Number	%		
SELF-FERTILE					
0719	ER 8719C1	94	1.1	3.0	5.5
0720A	ER 8720C1	86	1.2	3.0	5.0
0721A	ER 8721C1	98	0.0	4.0	6.0
0722	ER 8722C1	88	2.3	5.0	7.0
0722	NB 8722C1	91	4.4	5.0	6.5
0722	Inc. 8722C1	85	7.1	4.5	7.5
F78-546	Inc. F70-546 (78156)	84	1.2	6.0	7.5
0546	Inc. 9546E	90	1.1	5.0	8.0
0546H3	F66-562H0 x 9546E	88	1.1	5.0	8.0
F78-546H3	562H0 x 546 (78155)	85	2.4	5.0	8.0
0546H27	C758H0 x 9546E	85	2.4	3.5	7.0
0546HL7	8755H0 x 9546E	84	2.4	2.5	6.5
0758-1	Inc. 9758-1 (C758)	91	0.0	5.5	4.0
0758-1H0	9758-1H0 x 9758-1	90	0.0	5.5	5.0
0758-1H3	F66-562H0 x 9758-1	90	0.0	7.0	8.0
0758-1H72	C718H0 x 9758-1	95	0.0	7.0	7.5
0767-1	Inc. 9767E-1	98	1.0	6.5	7.0
0767-2	Inc. 9767E-2	80	16.3	6.0	6.0
0767-1H0	F66-562H0 x 9767E	87	2.3	7.0	8.0
0767-2H0	F67-563H0 x 9767E	84	0.0	6.0	7.5
0767H72	C718H0 x 9767E	88	3.4	6.5	7.5
9718H0 (C718)	3718H0 x 3718 (Iso.)	87	0.0	6.5	7.5
F79-779H0	C779 CMS x C779 (79434)	89	0.0	1.5	2.5
F80-566	Inc. 9563-30	90	0.0	3.5	4.5
F67-563	Lot 7433	80	3.8	6.0	8.0
0780	PMRS 779 lines	77	0.0	2.0	1.0

TEST 281. OBSERVATION TEST, SALINAS, CALIFORNIA, 1981

16 varieties with 2 replications					
7522H4	563H0 x 522-29	82	1.2	6.5	5.5
7522H21 Sp.	4536-97H0 x 522-29	86	2.3	7.5	5.0
0522-14H21		85	7.1	7.5	5.5
7522H0 Sp.	5522-29H0 x 5522-29	87	1.1	7.5	4.0
F67-563	mm inbred	70	0.0	4.5	5.5
9563-30 Sp.	FR inbred	93	2.2	3.5	4.0
F80-566	Inc. 9563-30	83	0.0	2.5	5.5
F80-566 CMS	9563-30H0 x 9563-30	85	1.2	2.5	7.0
F80-566H4	F67-563H0 x 9563-30	83	3.6	3.0	5.5
9522-14	FR inbred	81	0.0	6.5	6.0
9536-4	FR inbred	83	0.0	7.0	6.0
8536H0	CTR CMS	83	1.2	5.5	7.5
0562H0	8562H0 x 8562	90	3.3	4.5	7.5
8536	mm inbred	85	1.2	6.0	4.0
8562	Inc. F66-562	74	5.4	6.5	5.5
0562	Inc. 8562	81	0.0	5.5	6.5

TEST 481. YIELD EVALUATION OF 546H3 X POLLINATORS, SALINAS, CALIFORNIA, 1981

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: December 18, 1980
Harvested: September 16-17, 1981

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar Pounds	Beets Tons	(%)	Number	(%)	(%)
Y023H8	546H3 x Y923	17,449	44.07	19.84	139	0.2	3.0
Y049H8	546H3 x Y949Rr	17,351	44.12	19.69	138	0.0	0.3
Y031H8	546H3 x F79-31	17,098	43.42	19.70	141	0.5	1.0
Y941H8	546H3 x Y841	17,022	43.01	19.80	143	0.4	4.4
Y052H8	546H3 x Y952Rr	16,945	43.41	19.56	140	0.2	2.6
Y047H8	546H3 x Y947	16,868	43.66	19.37	138	0.1	1.5
0722H8	546H3 x 8722C1	16,716	43.06	19.41	135	0.0	3.1
Y026H8	546H3 x Y926	16,584	41.07	20.20	141	0.3	3.9
0719H8	546H3 x 719	16,463	41.30	19.96	143	0.0	2.2
Y048H8	546H3 x Y948	16,447	41.31	19.96	143	0.0	1.3
Y946H8	546H3 x Y846	16,334	42.15	19.39	141	0.0	0.9
E037H8	546H3 x E937 (C37)	16,224	42.28	19.23	142	0.3	0.1
US H10B	546H3 x C17 (86169)	16,188	41.93	19.31	146	0.4	1.3
U031H8	546H3 x F79-31 (80212)	16,109	41.84	19.28	137	0.2	0.5
Y051H8	546H3 x Y951, 53Rr	15,821	41.58	19.06	141	0.9	2.6
US H11	546H3 x C36 (80096)	15,683	40.79	19.23	140	0.1	0.4
Mean		16,581	42.44	19.56	140	0.2	1.8
LSD (.05)		830	1.97	0.67	NS	NS	1.6
Coefficient of Variation (%)		5.1	4.7	3.5	4.7	253.1	90.7
F value		3.1**	2.5**	1.9*	1.3NS	1.5NS	5.1**

1/ 546H3 = C562HO x C546. Y949 = F_1(C37 x C31E2). Y952 = F_1(C37 x Y41). 719 = Sel. from S^f-C17 for ERR and %S. Y846 = C2 Y46; C46 = C4 Y46. F79-31 = C31E2.

TEST 581. HYBRID TEST, SALINAS, CALIFORNIA, 1981

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: December 18, 1980
Harvested: September 22-23, 1981

Variety	Description 1/	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar Lbs	Beets Tons	(%)	Number	(%)	(%)
Y049H33	3546H72 x Y949Rr	17,641	46.54	18.99	136	0.0	1.2
E037HL3	9718HL11 x E937(C37)	17,517	46.40	18.90	140	0.0	0.9
Y031H26	F79-779HO x F79-31	17,378	45.15	19.33	137	0.9	3.2
E037H33	3546H72 x E937	17,324	45.64	19.06	140	0.2	0.2
E037HL7	8755HO x E837	17,233	45.90	18.82	142	0.0	6.4
E037H72	9718HO x E937	17,139	46.55	18.48	134	0.2	0.6
U031H8	546H3 x F79-31 (80212)	17,085	44.94	19.09	138	0.3	0.5
E037H38	9566 H72 x E937	17,044	44.99	19.04	137	0.5	1.4
Y031HL7	8755HO x F79-31	17,010	44.26	19.24	140	0.3	3.5
Y049H8	546H3 x Y949Rr	16,919	44.59	18.98	139	0.0	1.2
US H11	546H3 x C36 (80096)	16,546	43.44	19.11	141	0.3	0.9
US H10B	546H3 x C17 (86169)	16,249	43.50	18.68	142	0.3	1.3
E037H8	546H3 x E937 (C37)	16,125	43.25	18.68	141	0.3	0.3
E037H27	9758 HO x E937	15,899	42.57	18.71	141	0.2	0.2
E037H36	9566 H21 x E937	15,231	41.36	18.42	136	0.0	0.9
E037H37	9566 H26 x E937	14,870	40.44	18.46	136	0.0	1.4
Mean		16,701	44.34	18.87	139	0.2	1.5
LSD (0.5)		674	1.7	NS	NS	NS	1.8
Coefficient of Variation (%)		4.1	3.8	3.6	4.4	251.2	121.7
F value		11.5**	9.3**	1.4NS	1.2NS	1.7NS	6.3**

1/ 3546H72 = C718CMS x C546. 9718HL11 = 755CMS x C718. 9718HO = C718CMS. 546H3 = C562CMS x C546.
9566H72 = C718CMS x C566. 9566H21 = C563CMS x C566. 9566H26 = C779CMS x C566. 9758HO = C758CMS.

TEST 781. CA OF ADVANCED POLLINATORS WITH C718HO, SALINAS, CALIFORNIA, 1981

8 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: December 18, 1980
Harvested: September 28-29, 1981

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar	Beets				
		Pounds	Tons	%	Number	%	%
0719H72	C718HO x 719	19,419	51.03	19.12	145	0.1	3.6
Y052H72	C718HO x Y952Rr	19,346	53.12	18.23	139	0.3	4.1
Y931H72	C718HO x Y831E	19,325	51.63	18.77	148	0.6	2.0
Y049H72	C718HO x Y949Rr	19,251	52.42	18.36	137	0.2	3.1
E037H72	C718HO x E937	18,967	51.21	18.56	148	0.0	0.6
Y946H72	C718HO x Y846	18,950	49.08	19.39	145	0.3	1.9
Y941H72	C718HO x Y841	18,940	51.16	18.58	142	0.2	13.9
E037H8	546H3 x E937	18,141	48.33	18.81	149	0.0	0.4
Mean		19,042	51.00	18.73	144	0.2	3.7
LSD (.05)		NS	2.55	NS	6.34	NS	2.3
Coefficient of Variation (%)		4.80	5.00	4.20	4.40	255.40	63.20
F value		1.7 NS	3.2**	1.9 NS	4.0**	1.0 NS	27.8**

1/ 719 = reselected near-equivalent of S$_f$C17. Y952 = F_1 (C37 x Y41). Y949 = F_1 (C37 x C31). Y831E = C31E2. E937 = C37.

TEST 881. EVALUATION OF 755HO X POLLINATORS, SALINAS, CALIFORNIA, 1981

8 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: December 18, 1980
Harvested: September 28-29, 1981

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar Lbs	Beet Tons	%	Number	%	%
Y031HL7	8755HO x F79-31	19,424	52.32	18.57	145	0.7	4.2
Y049HL7	8755HO x Y949Rr	19,213	52.71	18.27	142	0.2	3.4
U031H8	546H3 x F79-31	19,172	51.66	18.57	141	0.3	1.0
0722HL7	8755HO x 8722C1	19,082	51.86	18.43	138	0.0	5.8
Y052HL7	8755HO x Y952Rr	19,009	53.05	17.93	138	1.0	6.0
E037H8	546H3 x E937	18,855	51.52	18.34	137	0.3	0.2
E037HL7	8755HO x E837	18,569	51.06	18.20	140	0.3	6.7
0719HL7	8755HO x 719	18,348	50.05	18.34	138	0.2	3.3
Mean		18,959	51.78	18.33	140	0.4	3.8
LSD (.05)		NS	NS	NS	NS	NS	2.6
Coefficient of Variation (%)		4.3	4.60	2.90	4.8	202.7	69.1
F value		1.5 NS	1.3 NS	1.2 NS	1.0 NS	1.5 NS	6.4**

[1/] 8755HO = CMS counterpart of 755 S^f, mm, A:aa population. See footnote 1 for Test 781.

TEST 981. GCA EVALUATION OF MONOGERM, RANDOM-MATING POPULATIONS, SALINAS, CALIFORNIA, 1981

8 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: December 19, 1980
Harvested: October 13, 1981

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting 8/31	Bolting 10/8
		Sugar Pounds	Beets Tons	%	Number	%	%	%
E037HL14	8755aa x E837	19,358	51.72	18.74	139	0.0	2.6	3.1
E037HL15	9755aa x E837	19,285	52.02	18.57	136	0.6	4.0	4.7
E037HL12	9744aa x E837	18,891	50.19	18.83	139	0.2	1.9	2.0
E037H8	546H3 x E937 (C37)	18,606	50.84	18.32	141	0.0	0.2	0.4
E037HL13	9745aa x E837	18,593	50.76	18.32	135	0.6	1.1	1.6
E037HL9	9740aa x E837	18,393	50.97	18.05	138	0.7	3.0	3.9
E037HL10	9741aa x E837	18,228	48.53	18.85	137	0.3	1.2	2.3
E037HL11	9742aa x E837	18,225	49.98	18.26	138	0.6	2.3	2.9
Mean		18,697	50.63	18.49	138	0.4	2.0	2.6
LSD (.05)		829	NS	NS	NS	NS	1.6	1.9
Coefficient of Variation (%)		4.4	4.70	3.10	5.00	198.4	80.40	72.60
F value		2.3*	1.7 NS	2.2 NS	0.6 NS	1.3 NS	4.4**	4.0**

1/ Genetic male sterile hybrids. 8755, 9755, etc., equal monogerm, near-T-O, self-fertile populations selected for disease resistance. 9744 = reselection of C789.

TEST 1281. EFFECTS OF MASS SELECTION ON GCA, SALINAS, CALIFORNIA, 1981

8 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: February 23, 1981
Harvested: October 1, 1981

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar	Beets				
		Pounds	Tons	%	Number	%	%
Y023H8	546H3 x Y923	12,719	36.11	17.64	137	0.3	0.0
915H8	546H3 x 915	12,102	34.80	17.43	124	0.5	0.0
Y030H8	546H3 x Y930	11,736	34.09	17.23	132	0.0	0.0
968H8	546H3 x 468	11,238	33.06	16.98	142	0.5	0.0
Y026H8	546H3 x Y926	11,646	32.93	17.72	140	0.2	0.2
959H8	546H3 x 959	11,283	33.48	16.86	134	0.6	0.0
E037H8	546H3 x E937	11,431	33.43	17.16	134	0.0	0.0
Y009H8	546H3 x US 22/3	10,779	31.33	17.27	129	0.6	1.3
Mean		11,617	33.65	17.29	134	0.3	0.2
LSD (.05)		806	2.21	NS	NS	NS	0.5
Coefficient of Variation (%)		6.9	6.50	3.60	10.7	234.5	275.3
F value		4.4**	3.3**	1.9 NS	1.3 NS	0.8 NS	6.3**

1/ 915 = Inc. US 15. Y923 = C_4 US 15. 468 = Inc. US 75. Y930 = C_5 US 75. 959 = Inc. US 56/2. Y926 = C_4 US 56/2. E937 = C_{11} US 75. Mass selection was for resistance to virus yellows but sugar yield was the primary selection criterion. This test appeared to have a very low incidence of virus yellows infection.

TEST 1381. ADVANCED USDA AND COMPANY HYBRIDS, SALINAS, CALIFORNIA, 1981

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: February 23, 1981
Harvested: October 5-6, 1981

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar Lbs	Beet Tons	(%)	Number	(%)	(%)
7334-02	Holly (Rec'd. 2/10/81)	12,391	34.38	18.03	140	1.1	0.1
7335-02	Holly (Rec'd. 2/10/81)	11,953	33.56	17.78	135	0.2	0.0
SS-Z1	Sprex (Rec'd. 2/4/81)	11,765	33.17	17.74	143	0.3	0.0
Y031HL7	8755HO x F79-31	11,572	32.30	17.89	144	0.3	0.0
GWH149	GW (Rec'd. 2/11/81)	11,527	32.89	17.59	144	0.0	0.3
S101H	Sprex (Rec'd. 2/4/81)	11,415	32.19	17.76	144	0.1	0.0
Y049H8	546H3 x Y949Rr	11,398	32.83	17.40	145	0.0	0.0
US H11	546H3 x C36 (80096)	11,373	33.31	17.11	145	0.0	0.0
E037H38	9566 H72 x E937	11,336	34.12	16.62	131	0.0	0.0
E037H8	546H3 x E937 (C37)	11,264	32.95	17.02	145	0.3	0.0
U031H8	546H3 x F79-31 (80212)	11,264	32.13	17.56	141	0.3	0.0
80MSC9	GW (Rec'd. 2/11/81)	11,227	32.24	17.41	149	0.6	0.0
MONO 309	Hilleshog (2/21/80)	11,115	33.22	16.70	142	0.2	0.0
9421	Betaseed (Rec'd. 2/6/81)	11,101	32.74	16.96	142	1.2	0.2
Y052H8	546H3 x Y952Rr	11,080	32.47	17.06	144	0.3	0.0
Y946H8	546H3 x Y846	11,014	31.87	17.30	148	0.0	0.0
Mean		11,425	32.90	17.37	143	0.3	0.04
LSD (.05)		NS	2.27	0.71	8.9	0.6	NS
Coefficient of Variation (%)		9.6	7.0	4.1	6.3	184.6	543.0
F value		0.87NS	0.78NS	2.8**	1.9*	3.5**	1.4NS

1/ Y949 = F_1(C37 x C31). E937 = C37. Y952 = F_1 (C37 x Y41). Y846 = C_2 Y46; C46 = C_4 Y46. 546H3 = C562CMS x C546. 9566H72 = C718CMS x C566.

TEST 681A[1/]. GENETIC IMPROVEMENT IN SUGAR YIELD, SALINAS, CALIFORNIA, 1981

8 x 8 latin square
2-row plots, 30 ft. long

Planted: December 19, 1980
Harvested: September 23-24, 1981

Variety[2/]	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar	Beet				
		Lbs	Tons	%	Number	%	%
964H8	546H3 x C64	17,376	47.27	18.42	143	0.1	0.9
917H8	546H3 x C17	16,812	46.03	18.32	140	0.5	0.3
964H2	4547H1 x C64	15,650	43.53	18.01	131	0.5	0.2
915	Inc. 915	15,205	42.61	17.86	130	0.2	2.5
959	Inc. 959	14,975	42.79	17.53	131	0.0	8.3
968	Inc. 468	14,389	40.91	17.62	132	0.0	3.1
Y905	Inc. 68-9163	12,597	34.77	18.11	126	0.2	38.4
Y009	Inc. US 22/3	10,044	30.59	16.46	127	0.7	67.3
Mean		14,631	41.06	17.79	133	0.3	15.1
LSD (.05)		909	1.99	0.74	6.4	NS	4.4
Coefficient of Variation (%)		6.2	4.80	4.10	4.8	311.1	29.0
F value		55.0**	65.8**	5.8**	6.9**	0.7 NS	253.0**

1/8 x 8 Latin square extracted from Test 681.

2/917H8 = 1979 USDA production of US H10B; 964HB = 1979 USDA production of US H7A; 964H2 = 1979 USDA production of US H6; 915 = 1979 Inc. of US 15; 968 = 1979 USDA Inc. of US 75; 959 = 1979 Inc. of US 56/2; Y009 = 1980 Inc. of US 22/3; Y905 = 1979 Inc. of R & G Pioneer. 546H3 = C562CMS x C546. 4547H1 = MS of NB1 x NB5.

TEST 681. GENETIC IMPROVEMENT FOR SUGAR YIELD, SALINAS, CALIFORNIA, 1981

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: December 19, 1980
Harvested: September 23-24, 1981

Variety[1/]	Description[2/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar	Beet				
		Lbs	Tons	%	Number	%	%
Y931H72	C718HO x Y831E	18,306	51.02	17.96	143	0.1	1.2
915H8	546H3 x 915	17,914	48.79	18.39	139	0.3	2.1
Y931H8	546H3 x Y831E	17,484	46.96	18.69	143	0.3	0.9
964H8	546H3 x C64	17,376	47.27	18.42	143	0.1	0.9
Y031HL7	8755HO x F79-31	17,108	45.68	18.78	137	0.2	1.5
917H8	546H3 x C17	16,812	46.03	18.32	140	0.5	0.3
959H8	546H3 x 959	16,747	45.87	18.31	137	0.2	1.0
968H8	546H3 x 468	16,423	45.83	17.95	140	0.2	0.9
964H2	4547H1 x C64	15,650	43.53	18.01	131	0.5	0.2
Y905H8	546H3 x 68-9163	15,364	42.21	18.19	139	0.3	9.0
915	Inc. 915	15,205	42.61	17.86	130	0.2	2.5
959	Inc. 959	14,975	42.79	17.53	131	0.0	8.3
968	Inc. 468	14,389	40.91	17.62	132	0.0	3.1
Y009H8	546H3 x US 22/3	14,218	39.89	17.89	137	0.1	34.9
Y905	Inc. 68-9163	12,597	34.77	18.11	126	0.2	38.4
Y009	Inc. US 22/3	10,044	30.59	16.46	127	0.7	67.3
Mean		15,663	43.42	18.03	136	0.2	10.8
LSD (.05)		877	2.05	.64	6.7	NS	3.6
Coefficient of Variation (%)		5.7	4.8	3.6	5.0	279.6	33.3
F value		46.8**	49.8**	5.6**	5.6**	0.6 NS	229.4**

1/ See footnote 2 for Test 681A.
2/ Y831E = C31E2. F79-31 = Inc. C31E2.

TEST 1181A[1/]. GENETIC IMPROVEMENT IN SUGAR YIELD, SALINAS, CALIFORNIA, 1981

8 x 8 latin square
2-row plots, 30 ft. long

Planted: February 23, 1981
Harvested: September 29-30, 1981

Variety[2/]	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar	Beet				
		Lbs	Tons	%	Number	%	%
964H8	546H3 x C64	13,053	38.69	16.91	138	0.6	0.0
917H8	546H3 x C17	12,709	37.93	16.75	141	2.2	0.0
964H2	4547H1 x C64	11,510	35.28	16.32	141	0.7	0.0
959	Inc. 959	11,453	33.96	16.87	127	1.3	0.0
968	Inc. 468	11,442	34.47	16.65	132	0.3	0.0
915	Inc. 915	11,324	33.58	16.86	136	0.6	0.0
Y905	Inc. 68-9163	10,996	31.72	17.35	138	1.5	1.7
Y009	Inc. US 22/3	10,694	31.72	16.86	132	0.5	16.8
Mean		11,647	34.67	16.82	136	1.0	2.3
LSD (.05)		500	1.65	0.48	NS	1.1	1.6
Coefficient of Variation (%)		4.3	4.70	2.80	7.70	108.0	68.9
F value		21.6**	19.8**	2.9*	1.9 NS	3.0*	109.3**

[1/] 8 x 8 Latin square extracted from Test 1181.
[2/] See footnote 2, Test 681A.

TEST 1181. GENETIC IMPROVEMENT FOR SUGAR YIELD, SALINAS, CALIFORNIA, 1981

16 entries x 8 replications, RCB
2-row plots, 30 ft. long

Planted: February 23, 1981
Harvested: September 29-30, 1981

Variety[1/]	Description[2/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Bolting
		Sugar	Beet				
		Lbs	Tons	%	Number	%	%
Y931H8	546H3 x Y831E	13,360	37.46	17.86	146	0.2	0.0
Y931H72	C718HO x Y831E	13,337	40.12	16.64	139	0.6	0.0
964H8	546H3 x C64	13,053	38.69	16.91	138	0.6	0.0
915H8	546H3 x 915	12,938	38.14	16.98	143	0.9	0.0
YO31HL7	8755HO x F79-31	12,911	37.46	17.24	138	0.3	0.0
917H8	546H3 x C17	12,709	37.93	16.75	141	2.2	0.0
Y905H8	546H3 x 68-9163	12,557	36.32	17.29	142	0.9	0.2
959H8	546H3 x 959	12,312	37.45	16.46	142	0.9	0.1
968H8	546H3 x 468	12,070	36.78	16.43	141	0.9	0.0
YO09H8	546H3 x US 22/3	11,902	35.38	16.84	138	0.9	2.5
964H2	4547H1 x C64	11,510	35.28	16.32	141	0.7	0.0
959	Inc. 959	11,453	33.96	16.87	127	1.3	0.0
968	Inc. 468	11,442	34.47	16.65	132	0.3	0.0
915	Inc. 915	11,324	33.58	16.86	136	0.6	0.0
Y905	Inc. 68-9163	10,996	31.72	17.35	138	1.5	1.7
YO09	Inc. US 22/3	10,694	31.72	16.86	132	0.5	16.8
Mean		12,160	36.03	16.89	138	0.8	1.3
LSD (.05)		528	1.53	0.49	9.3	1.1	1.2
Coefficient of Variation (%)		4.4	4.3	2.9	6.8	131.5	91.2
F value		20.6**	20.1**	5.0**	2.0*	1.7*	95.5**

1/ See footnote 2 for test 681A.
2/ Y831E = C31E2. F79-31 = Inc. C31E2.

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1980-81

Location: USDA-ARS, Imperial Valley Conservation Research Center

Soil type: Holtville silty clay loam

Previous crops: 1979 and 1980, cereals; 1978, sugarbeets.

Fertilization: 200 lbs 46:0:0 and 200 lbs 16:20:0 per acre, preplant.

Summary: 1980-81 Tests, Brawley, California

Test No.	Seeding Date 1980[1]	Entries per Test	No. Reps.	Rows per Plot[2]	Plot Length Ft.	1981 Harvest Date	Test Design
B181	9/11	16	8	2	24	5/13-14	RCB
B281	"	16	8	2	24	5/12-13	RCB
B381	"	8	8	2	24	5/14-15	RCB
B481	"	8	8	2	24	5/12	RCB
B581	"	40	2	1	24	5/15	3/
B681	"	6	5	2	24	5/16	RCB
B781	"	8	4	1	24	7/8-9	4/
Obs-1	"	16	2	1	24	Observation	Test
Obs-2	"	16	2	1	24	"	"

1/ Watered 9/11-14/80.
2/ Rows 32" wide.
3/ Progeny test in incomplete blocks.
4/ Split-split-plot with 2 inoc. dates and 4 disease treatments.

Irrigations: Sprinkled as needed to establish stands. Then furrow irrigated on 10/8, 11/3, 12/18/80; 2/17, 3/16, 4/16/81. Test B781 watered 5/18 and 6/18/81.

Thinned: September 29-30, 1980.

Herbicide: 10/8/80, 1 gal. Eptam 7E through irrigation water.

Diseases and insects: 10/3, 10/18 and 11/17, 0.8 lbs/A of Methomyl for fleabeetles, loopers, and armyworms. 2/3/81, 40 lbs/A sulfur dust for PM control. Virus yellows (BWY) was very mild with symptoms only evident on susceptible cultivars, e.g., US 75. PM was controlled but probably caused some yield reduction. Mites and Empaasca were prevalent at harvest. Bolting was extremely light. Very little root rot was present in yield trials.

Harvest and sugar analyses: Plots were dug with Holly's spike wheel lifter and sugar analyses made by Holly's tare lab.

Remarks: Stands were excellent. Test reliability should be very good. A fertility gradient occurred from the top to the bottom of the field and was probably due to leveling the field to a near zero grade. Roots were smooth with little sprangling, had small tops and crowns, and grew deeply into the soil.

We wish to acknowledge J. Robertson and C. Brown, I. V. Cons. Research Center, for plot supervision and P. Thomas, Davis, for data processing.

TEST B181. IMPERIAL VALLEY 546H3 X POLLINATOR HYBRID TEST, 1980-81

16 varieties, 8 replications, RCB
2-row plots, 24 ft. long, 32 in. rows

Planted: September 11, 1980
Harvested: May 13-14, 1981

Variety	Description[1]	Acre Yield[2] Sugar Pounds	Acre Yield[2] Beets Tons	Sucrose Percent	Bolting Percent	Root Rot Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating[3]
E037HL7	8755H0 x E837	10,220	29.43	17.46	0.2	0.3	157	96.5	1.9
Y031HL7	8755H0 x F79-31	9,937	28.20	17.74	0.0	0.0	161	96.4	2.3
Y023H8	546H3 x Y923	9,830	27.94	17.75	0.0	0.0	166	98.0	2.0
Y052H8	546H3 x Y952	9,735	27.37	17.91	0.0	0.2	158	96.3	2.1
0719H8	546H3 x 719	9,726	27.04	18.08	0.0	0.0	161	96.4	2.0
Y941H8	546H3 x Y841	9,673	27.23	17.87	0.0	0.0	165	97.0	1.9
Y941H24	7522H21 x Y841	9,598	27.17	17.80	0.0	0.5	160	97.2	2.3
Y946H8	546H3 x Y846	9,474	26.66	17.93	0.0	0.0	168	95.4	2.1
Y049H8	546H3 x Y949	9,448	26.49	17.91	0.0	0.3	157	96.9	1.9
US H11	546H3 x F77-36 (78016)	9,349	27.03	17.37	0.0	0.0	164	96.0	2.1
U031H8	546H3 x F79-31 (80212)	9,167	25.58	18.07	0.0	0.0	149	97.4	2.7
E037H8	546H3 x E937	9,131	25.06	17.64	0.0	0.0	166	95.4	2.0
0722H8	546H3 x 8722C1	9,125	25.50	17.97	0.0	0.2	161	97.1	2.2
Y026H8	546H3 x Y926	9,122	25.43	18.01	0.0	0.0	157	96.8	2.3
Y031H8	546H3 x F79-31	9,080	25.38	18.03	0.0	0.3	158	97.4	2.1
US H10B	546H3 x C17 (86169)	8,942	26.24	17.14	0.0	0.0	166	95.2	2.4
Mean		9,472	26.80	17.79	0.0	0.1	161	96.6	2.1
LSD (.05)		598	1.70	0.43	NS	0.3	9.2	0.8	NS
C. V. (%)		6.4	6.4	2.50	1131.4	311.7	5.8	0.9	22.7
F value		2.9**	3.5**	3.1**	1.0 NS	1.8*	2.1*	7.0**	1.4 NS

1/ 546H3 = C562CMS x C546; 8755H0 = CMS of S^f, mm, A:aa population; 7522H21 = C536CMS x C522. E837 = C17E2; E937 = C17E3 = C37. Y952 = F_1(E37rr x Y41R-)Rr; Y949 = F_1(E37rr x C31R-)Rr. 719 = S^f near-equivalent of C17; 8722 = S^f near-equivalent of C01.

2/ Yields adjusted to clean weight basis.

3/ Brei NO_3-N by Orion probe. Ratings of 1, 2, ..., 9 correspond to NO_3-N values of 0 to > 250 ppm and to diphenylamine spot test ratings of 1 through 5.

TEST B281. IMPERIAL VALLEY HYBRID TEST, 1980-81

16 varieties, 8 replications, RCB
2-row plots, 24 ft. long, 32 in. rows

Planted: September 11, 1980
Harvested: May 12-13, 1981

Variety	Description[1]	Acre Yield[2] Sugar Pounds	Acre Yield[2] Beets Tons	Sucrose Percent	Bolting Percent	Root Rot Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating[3]
E037HL15	9755aa x E837	10,056	29.97	16.88	0.2	0.0	161	95.9	2.4
E037HL3	9718HL11 x E937	9,849	28.53	17.35	0.0	0.0	161	94.8	1.5
E037H72	C718HO x E937	9,708	28.23	17.29	0.0	0.0	159	95.0	1.8
US H10B	546H3 x C17 (86169)	9,395	27.57	17.10	0.0	0.2	170	95.5	1.9
US H11	546H3 x F77-36 (78016)	9,356	27.04	17.35	0.0	0.0	163	95.1	2.1
E037HL9	9740aa x E837	9,337	27.52	17.04	0.4	0.0	159	95.9	2.2
E037HL13	9745aa x E837	9,322	27.30	17.16	0.0	0.0	158	96.1	1.5
Y031H8	546H3 x F79-31	9,214	25.69	18.05	0.0	0.0	164	96.9	1.8
E037H38	9566H72 x E937	9,134	27.03	17.04	0.0	0.0	160	94.9	2.1
E037H8	546H3 x E937	9,066	26.26	17.33	0.0	0.0	166	95.1	2.3
E037HL11	9742aa x E837	8,965	26.39	17.04	0.0	0.0	159	95.7	2.3
E037HL10	9741aa x E837	8,958	25.73	17.48	0.0	0.0	156	95.3	1.5
E037HL12	9744aa x E837	8,865	25.44	17.46	0.0	0.0	158	95.6	1.5
E037H27	C758HO x E937	8,718	24.64	17.70	0.0	0.0	163	94.7	1.8
E037H36	9566H21 x E937	8,568	24.54	17.52	0.0	0.0	161	95.1	1.4
E037H37	9566H26 x E937	7,976	23.54	17.02	0.0	0.2	161	93.6	1.4
Mean		9,155	26.59	17.30	0.0	0.0	161	95.3	1.8
LSD (.05)		526	1.44	0.45	NS	NS	NS	1.1	0.7
C. V. (%)		4.9	5.5	2.6	859.1	773.2	6.8	1.1	38.6
F value		7.3**	10.4**	3.6**	0.9 NS	1.0 NS	0.7 NS	4.1**	2.0*

1/ E837 = C17E2; E937 = C37 = C17E3. 9755, 9740, 9741, 9742, 9744, and 9745 = S^f, mm, A:aa populations. 9718HL11 = 755CMS x C718; 9566H72 = C718HO x C566; 9566H21 = C536HO x C566; 9566H26 = C779HO x C566.
2/ Yields adjusted to a clean weight basis.
3/ Brei NO_3-N by Orion probe.

TEST B381. IMPERIAL VALLEY EVALUATION OF 0755HO X POLLINATORS, 1980-81

8 varieties, 8 replications, RCB
2-row plots, 24 ft. long, 32 in. rows

Planted: September 10, 1980
Harvested: May 14-15, 1981

Variety	Description[1]	Acre Yield[2] Sugar	Acre Yield[2] Beets	Sucrose	Bolting	Root Rot	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Pounds	Tons	Percent	Percent	Percent	Number	Percent	Rating[3]
Y052HL7	8755HO x Y952	10,348	30.30	17.15	0.3	0.0	167	96.2	2.1
Y049HL7	8755HO x Y949	10,186	29.61	17.33	0.4	0.0	163	96.6	2.1
0719HL7	8755HO x 719	10,110	28.94	17.54	0.0	0.0	160	96.5	2.2
Y031HL7	8755HO x F79-31	10,038	28.70	17.61	0.0	0.2	165	97.0	2.6
E037HL7	8755HO x E837	9,958	29.56	16.92	0.2	0.2	162	96.5	2.3
0722HL7	8755HO x 8722C1	9,842	28.71	17.20	0.3	0.0	163	97.3	2.1
Y031H8	546H3 x F79-31	9,397	26.12	18.10	0.0	0.0	160	97.4	2.2
E037H8	546H3 x E937	9,164	26.43	17.39	0.0	0.0	165	94.8	2.1
Mean		9,880	28.55	17.41	0.2	0.0	163	96.5	2.2
LSD (.05)		554	1.70	0.43	NS	NS	NS	0.8	NS
C. V. (%)		5.6	5.90	2.50	291.9	571.4	6.9	0.8	25.7
F value		4.3**	6.3**	5.5**	1.3 NS	0.8 NS	0.4 NS	8.2**	0.7 NS

1/ 8755HO = CMS counterpart of 755 S^f, mm, A:aa population. Y952 = F_1(E37rr x Y41R-)Rr; Y949 = F_1(E37rr x C31E2R-)Rr; 719 = S^f near-equivalent of C17. 8722 = S^f near-equivalent of C01. E937 = C37.

2/ Yields adjusted to clean weight basis.

3/ Brei NO_3-N by Orion probe.

TEST B481. IMPERIAL VALLEY TEST OF GENETIC IMPROVEMENT IN SUGAR YIELD, 1980-81

8 varieties, 8 replications, RCB
2-row plots, 24 ft. long, 32 in. rows

Planted: September 11, 1980
Harvested: May 12, 1981

Variety[1]	Description	Acre Yield[2] Sugar Pounds	Acre Yield[2] Beets Tons	Sucrose Percent	Bolting Percent	Root Rot Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating[3]
917H8	546H3 x C17	10,031	28.40	17.69	0.2	0.0	161	95.8	1.1
964H8	546H3 x C64	9,548	28.25	16.99	0.0	0.0	162	96.7	1.6
915	Inc. 915	8,815	25.90	17.06	0.0	0.0	155	96.4	1.2
964H2	4547H1 x C64	8,653	25.54	17.01	0.0	0.0	157	97.6	1.4
968	Inc. 468	8,621	26.07	16.60	0.0	0.2	162	96.3	1.5
959	Inc. 959	8,443	25.17	16.83	0.0	0.2	152	96.7	1.4
Y009	Inc. US 22/3	7,858	22.90	17.18	26.4	0.0	153	96.2	2.0
Y905	Inc. 68-9163	6,786	19.17	17.75	2.2	0.0	155	93.7	2.2
Mean		8,594	25.17	17.14	3.6	0.0	157	96.2	1.6
LSD (.05)		571	1.76	0.48	2.8	NS	NS	1.12	NS
C. V. (%)		6.6	7.0	2.8	76.3	523.9	6.5	1.2	51.4
F value		24.3**	23.2**	5.7**	91.2**	1.0 NS	1.3 NS	8.1**	1.7 NS

1/ 917H8 = 1979 USDA production of US H10B; 964H8 = 1979 USDA production of US H7A; 964H2 = 1979 USDA production of US H6; 915 = 1979 USDA production of US 15; 968 = 1979 USDA production of US 75; 959 = 1979 USDA production of US 56/2; Y009 = 1980 USDA production of US 22/3; Y905 = 1979 USDA production of R&G Pioneer.

2/ Yields adjusted to a clean weight basis.

3/ Brei NO_3-N by Orion probe.

TEST B681. IMPERIAL VALLEY FODDER BEET TEST, 1980-81

6 varieties, 5 replications, RCB
2-row plots, 24 ft. long, 32 in. rows

Planted: September 10, 1980
Harvested: May 15-16, 1981

Variety[3/]	Description	Acre Yield[1/] Sugar	Acre Yield[1/] Beets	Sucrose	Bolting	Root Rot	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Pounds	Tons	Percent	Percent	Percent	Number	Percent	Rating[2/]
Oscar	(FB19) Anisoploid FB	12,589	57.01	11.16	0.0	0.3	130	96.7	3.3
Monoblanc	(FB46) 2n SB x 4n FB Hybrid	11,425	40.49	14.18	0.3	0.3	147	93.7	2.4
Y031HL7	8755H0 x F79-31	11,185	32.45	17.29	0.0	0.0	159	95.6	1.7
Monorosa	(FB44A) 2n SB x 2n FB Hybrid	10,698	36.11	14.96	0.0	0.3	154	93.5	3.2
Rota	(FB7) O.P., 2n FB	9,273	62.75	7.61	0.0	0.0	139	95.1	3.8
US H11	546H3 x F77-36 (78016)	9,257	27.59	16.82	0.0	0.0	159	94.3	1.7
Mean		10,738	42.73	13.67	0.1	0.1	148	94.8	2.7
LSD (.05)		1,150	8.12	1.10	NS	NS	NS	1.8	0.8
C. V. (%)		8.1	14.40	6.1	547.7	332.2	12.7	1.4	22.9
F value		11.1**	26.1**	96.9**	1.0 NS	0.6 NS	2.0 NS	4.3**	10.3**

1/ Yields adjusted to clean weight basis.
2/ Brei NO_3-N by Orion probe. Ratings of 1, 2, ..., 9 correspond to NO_3-N values of 0 to > 250 ppm and to diphenylamine spot test ratings of 1 through 5.
3/ Seed of FB and SB x FB varieties was obtained from Dr. Doney, Logan, Utah.

VARIETY TEST, TRACY, CA, 1981
By Holly Sugar Corporation

13057 Commercial 57A (Fergusen)
12 entries x 8 reps, RCB
1-row (30") x 19 ft.

Planted: April 30, 1981
Harvested: October 9, 1981

Variety	Ext. Sugar Lbs/A	Ext. %	Sugar Yield Lbs/A	Beet Yield T/A	Sucrose %	Beets/ 100' No.
US H11	9,531	88.7	10,749	34.1	15.76	140
Y941H8	9,526	88.3	10,778	32.9	16.37	146
Y946H8	9,217	88.3	10,436	32.7	15.96	145
Y052H8	8,779	88.8	9,884	30.6	16.12	130
0722H8	8,285	87.3	9,488	29.7	15.95	141
Y049H8	8,079	88.7	9,109	28.7	15.89	139
0719H8	7,714	88.6	8,685	27.3	15.86	134
Test Mean	9,018	88.6	10,177	31.5	16.17	142
C. V. (%)	11	1.7	11	11.1	2.49	
LSD (.05)	1,029	NS	1,132	3.5	0.40	
F value	4.33**	1.39 NS	4.53**	4.44**	7.46**	

Variety	Rot %	Amino N PPM	Na PPM	K PPM	Imp. Index	KSL Lbs/A
US H11	1.5	62	40	337	752	1,218
Y941H8	1.0	72	43	341	776	1,251
Y946H8	0.5	66	40	353	779	1,219
Y052H8	1.1	61	46	345	750	1,105
0722H8	3.3	77	48	355	843	1,202
Y049H8	3.4	55	49	352	751	1,029
0719H8	2.0	65	31	351	763	971
Test Mean	1.8	68	42	336	763	1,158
C. V. (%)		35	17	7	13	16
LSD (.05)		NS	7	23	NS	190
F value		0.7 NS	6.0**	5.2**	1.3 NS	3.0**

VARIETY TEST, TRACY, CA, 1981
By Holly Sugar Corporation

17057 Commercial 57B (Martin)
12 entries x 8 reps, RCB
1-row (30") x 19 ft.

Planted: April 30, 1981
Harvested: October 9, 1981

Variety	Sugar Lbs/A	Ext. %	Sugar Yield Lbs/A	Beet Yield T/A	Sucrose %	Beets/ 100' No.
0719H8	9,105	83.8	10,854	46.8	11.62	139
0722H8	8,767	80.7	10,862	52.2	10.43	138
Y941H8	8,558	83.5	10,190	46.7	10.91	132
Y049H8	8,355	80.9	10,313	49.6	10.39	134
Y052H8	8,338	82.0	10,154	46.4	10.96	133
Y946H8	8,097	79.4	10,214	47.8	10.75	140
US H11	7,873	79.3	9,858	48.6	10.15	136
Test Mean	8,920	82.2	10,822	48.4	11.21	137
C. V. (%)	11	4.4	9	8.3	5.67	
LSD (.05)	943	3.6	998	NS	0.63	
F value	4.38**	2.07*	3.86**	1.39 NS	9.90**	

Variety	Severe P. Mildew August %	Severe P. Mildew October %	Amino N PPM	Na PPM	K PPM	Imp. Index	KSL Lbs/A
0719H8	13	38	67	112	249	1,081	1,748
0722H8	11	37	61	173	232	1,286	2,094
Y941H8	6	22	46	159	224	1,101	1,632
Y049H8	12	30	62	168	225	1,274	1,958
Y052H8	12	25	52	179	241	1,198	1,816
Y946H8	9	25	82	162	237	1,373	2,116
US H11	18	36	71	162	230	1,377	1,985
Test Mean	13	36	68	148	230	1,185	1,902
C. V. (%)			50	18	9	20	21
LSD (.05)			NS	26	20	238	NS
F value			0.9 NS	6.5**	4.7**	2.1*	1.3 NS

TEST 2381-1. ERWINIA AND POWDERY MILDEW EVALUATION TEST,
SALINAS, CALIFORNIA, 1981

24 entries x 4 replications
1-row plots, 24 ft. long

Planted: May 13, 1981
Inoculated (E): July 23, 1981
Harvested: November 2-3, 1981

Variety	Description	No. Roots	Erw. Reaction DI[1]	Erw. Reaction % Healthy[2]	P. M. Scores[3] 8/19	8/29	9/9	9/15
Y905	Inc. 68-9163 (R&G Pion.)	102	9.0	83.3	4.3	5.4	5.3	6.0
Y906	Inc. R&G O-T-42	111	5.6	85.6	4.7	6.2	5.8	6.5
Y009	Inc. US 22/3	110	8.1	80.0	5.7	6.2	6.0	7.8
915	Inc. 915 (US 15)	107	7.5	82.2	2.7	3.0	2.3	3.0
959	Inc. 959 (US 56/2)	107	3.4	90.7	3.7	4.8	4.5	6.5
968	Inc. 468 (US 75)	107	10.0	78.5	4.3	4.4	6.0	6.5
917	Inc. 417 (C17)	107	23.6	57.0	5.3	5.2	6.3	7.3
F80-37	Inc. E937 (C37)	122	0.5	93.4	5.3	5.8	7.0	7.5
F79-36	Inc. C36 (79377)	99	0.4	97.0	5.0	5.6	6.5	7.5
964	Inc. 364 (C64)	112	4.3	89.3	2.5	3.0	2.8	3.5
964H2	4547H1 x 364 (US H6)	138	2.3	92.0	5.0	5.0	6.0	6.0
964H8	546H3 x 364 (US H7A)	126	0.4	96.0	3.0	4.4	5.3	4.5
917H8	546H3 x 417 (US H10B)	111	10.2	72.1	5.0	5.8	7.3	7.5
E936H8	546H3 x E736 (US H11)	120	0.2	96.7	6.5	6.8	7.5	7.8
US H11	(80096)	113	1.3	90.3	5.5	6.6	6.8	7.5
Y931H8	546H3 x Y831E (C31E2)	117	2.7	91.5	4.5	4.4	5.5	5.8
F78-546H3	562HO x 546 (78155)	126	3.9	91.3	5.0	6.8	7.5	7.3
4547H1	1502HO x 2547 (NB1 x NB2)	116	1.7	87.9	8.0	8.4	7.8	7.8
E840	Inc. E640	97	66.3	5.2	5.0	5.8	6.0	7.3
Y041	NB-ER Y841	126	0.8	96.8	2.5	2.4	1.8	2.5
Y031	NB-ER Y831E	112	14.6	75.0	4.0	4.2	4.8	5.0
Y046	NB-ER Y846	112	4.0	91.1	2.5	2.2	3.8	4.8
0755	9755aa x A	120	6.2	90.0	4.0	4.2	3.3	3.0
Y052HL7	8755HO x Y952Rr	137	10.5	80.3	4.0	4.6	5.8	5.8

1/DI=Disease Index=mean % rot/root. Plants scored on a scale of 0, 1, 7, 25, 50, 75, 93, and 100% rot per root.
2/Roots with scores of 0 and 1% rot were considered healthy.
3/PM=Powdery Mildew. Ratings made on a scale of 0 to 9.

TEST 2381-2. ERWINIA AND POWDERY MILDEW EVALUATION TEST,
SALINAS, CA, 1981

241 entries x 1 or 2 replications
1-row plots, 24 ft. long

Planted: May 13, 1981
Inoculated (E): July 23, 1981
Harvested: December 16, 1981

Variety	Description	No. Roots	Erw. Reaction DI[1]	Erw. Reaction % Healthy[2]	P. M. Scores[3] 8/19	8/29	9/9	9/15
HYBRIDS								
HH27	Holly (rec. 1979)	61	3.0	91.6	2.0	2.0	1.5	3.5
GWD2	GW (rec. 2/11/80)	62	7.9	82.3	7.0	6.5	7.0	6.5
SSE1	Sprex (rec. 3/7/80)	61	4.7	87.0	6.0	5.5	6.5	8.0
Monoricca	Hilleshog (rec. 2/21/80)	55	11.5	76.4	3.0	3.5	2.5	4.5
Mono 309	" "	59	7.9	82.9	4.0	4.5	5.0	6.5
9421	Betaseed (098)(2/6/81)	63	16.3	81.0	3.0	4.0	4.5	5.5
UO31H8	546H3 x C31E2 (80212)	55	11.7	81.9	4.0	5.0	6.0	5.5
US H11	80096	51	0.4	95.7	7.0	5.5	6.5	7.5
US H10B	86169	53	17.7	70.0	6.0	5.5	6.5	7.0
GWH149	(7033) (2/11/81)	57	13.6	76.3	6.0	5.5	6.5	7.0
80MSC9	(80379)(2/11/81)	59	18.7	65.6	7.0	5.0	5.5	6.5
7335-02	Holly	52	12.6	79.2	4.0	3.5	4.0	3.5
7334-02	Holly	43	9.5	81.3	4.0	4.5	5.5	6.0
SS-Z1	SS111Z (2/4/81)	56	9.3	83.5	5.0	5.0	6.5	7.0
S101H	Sprex (2/4/81)	55	6.6	83.7	4.0	4.5	5.5	6.0
H79287	Sprex (2/4/81)	48	1.3	94.5	4.0	5.0	5.5	6.0
US H8	546H3 x NB7 (Holly)	41	9.2	82.8	8.0	7.5	7.0	7.0
US H9B	" x C13 (1050)	53	21.6	57.1	7.0	7.0	7.5	8.0
US H11	" x C36 (78016)	59	0.9	93.7	6.0	6.0	6.0	7.5
US H10B	86169	55	29.9	52.9	6.0	6.0	6.5	7.0
UO31H8	546H3 x C31E2 (80212)	59	7.7	79.8	5.0	5.0	6.0	6.5
YO09H8	" x US 22/3	60	12.1	70.2	6.0	6.0	5.0	6.5
YO23H8	546H3 x Y923	57	6.0	83.5	5.0	5.5	6.0	5.5
YO26H8	" x Y926	61	9.0	86.3	5.0	5.0	4.0	5.5
YO30H8	" x Y930	55	10.8	73.6	8.0	7.5	6.5	7.5
YO31H8	" x F79-31	63	7.9	90.2	4.0	4.0	5.5	5.0
YO47H8	" x Y947	58	6.8	79.8	5.0	5.5	4.5	6.0
US H11	(80096)	69	2.7	85.4	7.0	6.0	6.5	7.0
YO48H8	" x Y948	66	7.9	84.5	6.0	6.0	5.5	6.5
YO49H8	" x Y949Rr	61	12.2	76.7	4.0	5.5	5.5	6.5
YO50H8	" x Y950Rr	57	2.4	87.3	4.0	4.5	4.5	6.5
EO37H8	" x E937 (Iso.)	55	2.2	83.8	4.0	5.0	5.5	7.0
YO51H8	" x Y951, 3Rr	61	4.4	93.1	6.0	6.5	6.0	6.5
YO52H8	" x Y952Rr	60	1.9	95.0	6.0	5.5	6.0	6.5
EO37H8	" x E937 (C37)	53	2.0	88.9	7.0	6.5	6.5	6.5
0719H8	" x S^f-C17	56	4.2	91.7	5.0	4.5	5.5	6.5
0722H8	" x 8722C1	59	3.3	93.3	6.0	6.5	6.0	7.0
E840H8	" x E640	42	20.7	54.6	5.0	5.5	4.5	6.5
8717H8	" x 7717	61	3.4	93.2	5.0	4.5	4.0	5.0
8719H8	" x 6719	55	5.8	84.8	5.0	4.0	5.0	4.5

TEST 2381-2. ERWINIA AND POWDERY MILDEW EVALUATION TEST, SALINAS, CA, 1981 (CONTINUED)

917H8	546H3 x 417 (C17)	55	16.5	64.0	6.0	5.5	6.0	7.0
E837H8	" x E737 (C17E1)	57	7.8	80.6	5.0	6.0	6.0	7.0
E937H8	" x E837 (C17E2)	60	6.3	85.1	7.0	6.5	6.5	7.0
E037H8	" x E937 (C37)	62	2.3	91.8	6.0	6.5	6.0	7.0
US H11	(80096)	61	4.4	89.1	7.0	6.5	6.0	7.5
Y941H8	" x Y841	61	1.0	96.9	4.0	4.5	5.0	6.5
Y942H8	" x Y842	44	2.4	90.7	5.0	5.0	5.0	7.0
Y946H8	" x Y846	54	16.4	67.8	4.0	4.0	5.5	6.0
Y601H8	" x Y401A (C01)	30	3.1	96.7	4.0	5.0	4.0	6.0
Y731H8	" x Y631E (C31)	28	2.7	96.4	5.0	7.0	5.0	7.0
Y931H8	" x Y831E (C31E2)	28	3.3	96.4	4.0	6.0	4.0	7.0
Y031H8	" x F79-31	25	5.0	92.0	4.0	5.0	4.0	6.0
U031H8	" x C31E2 (80212)	28	4.5	89.3	5.0	5.0	3.0	5.0
7335-011	Exp. Hybrid	22	6.6	90.9	4.0	4.0	3.0	5.0
7334-011	" "	26	9.4	84.6	5.0	6.0	4.0	4.0
7335-012	" "	25	0.4	96.0	3.0	3.0	4.0	3.0
7334-012	" "	25	9.3	80.0	4.0	3.0	2.0	3.0
73303-012	" "	21	19.1	71.4	5.0	6.0	6.0	7.0
73305-012	" "	23	4.7	91.3	6.0	6.0	4.0	7.0
63208-02	" "	24	5.2	87.5	3.0	4.0	5.0	6.0
7335-05	" "	23	4.4	95.7	2.0	2.0	4.0	2.0
7334-05	" "	26	0.4	96.2	1.0	2.0	1.0	3.0
73303-05	" "	22	11.7	81.8	1.0	2.0	1.0	2.0
917H8	546H3 x 417 (C17)	25	9.5	88.0	5.0	6.0	8.0	8.0
US H11	(80096)	34	0.8	97.1	6.0	7.0	7.0	8.0
Y031HL7	8755HO x F79-31	35	0.0	100.0	3.0	4.0	3.0	6.0
Y049HL7	8755HO x Y949Rr	35	9.0	80.0	4.0	5.0	4.0	7.0
Y052HL7	8755HO x Y952Rr	33	0.0	100.0	3.0	4.0	3.0	6.0
E037HL7	8755HO x E837	33	4.0	90.9	6.0	7.0	7.0	8.0
0719HL7	8755HO x S^f-C17	32	2.9	96.9	5.0	5.0	7.0	7.0
0722HL7	8755HO x 8722C1	35	10.1	85.7	5.0	5.0	6.0	6.0
E936H72	F74-718HO x E736	30	0.1	100.0	6.0	6.0	4.0	7.0
917H8	546H3 x 417	32	9.4	84.4	6.0	7.0	6.0	7.0
Y931H72	F74-718HO x Y831E	29	7.2	79.3	4.0	4.0	6.0	5.0
Y049H72	9718HO x Y949Rr	29	5.1	82.8	4.0	5.0	4.0	6.0
Y052H72	" x Y952Rr	34	11.4	82.4	5.0	5.0	4.0	6.0
E037H72	" x E937	31	9.1	77.4	6.0	6.0	4.0	7.0
0719H72	" x S^f-C17	34	7.4	85.3	6.0	5.0	6.0	6.0
Y941H72	F74-718HO x Y841	30	4.4	86.7	4.0	5.0	7.0	4.0
Y946H72	" x Y846	31	11.2	74.2	5.0	4.0	5.0	5.0
Y031H26	F79-779HO x F79-31	67	3.9	89.8	4.0	4.0	3.0	2.5
E037H27	9758-1HO x E937	67	7.7	86.1	7.0	7.5	7.5	8.0
E037H36	9566 H21 x E937	63	1.7	88.5	7.0	8.0	7.5	8.0
E037H37	9566 H26 x E937	63	3.7	90.6	6.0	6.0	6.0	6.5
E037H38	9566 H72 x E937	60	3.8	90.9	7.0	7.0	7.0	7.5
E037HL3	9718H11 x E937	55	2.7	94.0	6.0	6.5	6.5	7.0

TEST 2381-2. ERWINIA AND POWDERY MILDEW EVALUATION TEST, SALINAS, CA, 1981 (CONTINUED)

917H8	546H3 x 417	66	6.0	85.0	6.0	6.5	7.0	7.5
US H11	80096	63	2.1	88.4	6.0	7.0	7.0	8.0
E037HL9	9740aa x E837	55	18.6	75.0	4.0	4.5	5.0	7.0
E037HL10	9741aa x E837	59	11.4	65.0	6.0	6.5	7.0	7.5
E037HL11	9742aa x E837	54	14.8	71.4	5.0	5.0	6.0	7.5
E037HL12	9744aa x E837	58	2.3	82.0	5.0	6.0	7.0	8.0
E037HL13	9745aa x E837	50	18.2	64.8	5.0	6.0	6.5	7.5
E037HL15	9755aa x E837	54	12.9	73.1	6.0	5.5	7.0	7.5
E937H24	7522H21 x E837	33	11.6	72.7	6.0	8.0	7.0	7.0
Y941H24	7522H21 x Y841	30	16.1	76.7	4.0	6.0	6.0	5.0
OPEN-POLLINATED LINES								
917	Inc. 417 (C17)	53	35.5	48.0	6.0	7.0	7.0	8.0
E637	Inc. E537 (C17E1)	54	12.4	85.3	5.0	6.5	6.5	7.0
E937	Inc. E837 (C17E2)	57	4.7	93.6	5.0	7.0	7.0	7.5
E037	Inc. E937 (C37)	52	0.2	97.9	6.0	7.0	7.0	8.0
F80-37	Inc. E937 (C37)	58	2.2	97.0	6.0	6.5	7.0	8.0
Y631	Inc. Y331 (C31)	53	17.4	66.5	2.0	3.0	4.5	4.0
Y731	Inc. Y631 (C31E1)	53	11.6	79.6	2.0	3.5	3.0	3.0
Y931	Inc. Y831E (C31E2)	47	7.1	85.3	3.0	4.0	3.0	3.5
F79-31	Inc. Y831E (C31E2)	41	13.8	72.0	3.0	3.5	1.5	2.5
Y931E	YR-ER Y631E	54	7.4	87.5	2.0	3.0	2.5	2.5
Y031	NB-ER Y831E	52	12.9	70.8	3.0	4.0	4.0	3.5
F79-36	Inc. C36 (79377)	51	1.4	94.2	5.0	5.5	7.0	6.5
E840	Inc. E640	45	67.4	19.5	4.0	5.5	7.0	7.5
813	Inc. 413C (C13)	53	52.5	24.3	4.0	5.5	6.0	7.0
F77-36	Inc. C36 (7322)	48	2.6	87.1	4.0	5.5	7.0	8.0
F78-36	Inc. F77-36 (78087)	46	3.0	81.6	5.0	6.0	7.0	7.5
F79-36	Inc. C36 (79377)	54	0.8	94.6	5.0	6.0	6.0	7.0
PM-1	22-9, 13, 6	60	0.1	98.2	2.0	3.0	4.0	6.0
-2	22-7, 8	56	4.9	89.3	3.0	3.5	3.0	4.0
-3	90-1, 20, 28	36	3.6	93.5	1.0	1.0	1.0	3.0
-4	22-3B	55	0.6	96.7	1.0	2.5	3.0	4.5
E840	Inc. E640	50	69.3	10.2	3.0	7.0	7.5	8.0
PM-5	435-8H-2-1	54	0.5	94.6	3.0	3.0	3.5	4.5
-6	22-9	56	1.8	94.8	3.0	2.0	2.0	3.0
PM-8	435-8A-1-2	54	0.5	96.1	2.0	2.0	2.0	2.0
F79-36	Inc. C36 (79377)	49	0.5	96.0	5.0	5.0	7.0	7.5
PM-9	22-4	58	0.3	98.4	2.0	2.0	3.0	3.0
-10	90-28	46	1.4	88.4	1.0	2.0	2.0	2.0
-11	634-46-4-2F	54	4.3	77.1	2.0	2.0	2.5	2.5
Y030	Inc. Y930	30	5.5	70.2	4.0	7.5	8.0	8.5
Y023	Inc. Y923	35	11.0	66.7	3.0	4.0	5.0	6.5
Y026	Inc. Y926	34	8.2	77.5	2.0	4.5	6.5	6.0
Y039	NB-ER Y839	65	5.9	89.2	3.0	5.0	5.0	4.5
Y040	NB-ER Y840	76	5.2	88.4	6.0	7.0	6.5	7.5
917	Inc. 417	54	35.5	48.1	4.0	5.5	6.0	7.0
964	Inc. 364	60	1.3	93.3	2.0	2.0	3.5	3.0
Y746	Inc. Y646	60	11.2	80.2	3.0	5.0	5.5	5.5
Y946	Inc. Y846	64	5.0	87.1	3.0	3.5	5.5	5.5
Y046	NB-ER Y846	62	9.0	85.5	3.0	2.5	2.5	3.0
Y441	Inc. 3255	60	4.9	86.6	4.0	3.0	2.0	2.5

TEST 2381-2. ERWINIA AND POWDERY MILDEW EVALUATION TEST, SALINAS, CA, 1981 (Continued)

Y741	Inc. Y641	63	7.7	82.4	3.0	2.5	2.5	3.0
Y941	Inc. Y841	62	4.8	87.1	4.0	2.0	2.0	2.0
Y041	NB-ER Y841	57	4.4	93.0	2.0	1.5	2.5	2.5
Y041P	PMR 8235, 6	54	5.5	88.6	3.0	1.5	1.0	2.0
F79-36	Inc. C36 (79377)	52	0.5	94.4	6.0	6.0	7.0	7.5
Y942	Inc. Y842	47	6.7	91.3	5.0	5.0	6.5	6.5
Y042 (C42)	YR-ER Y842	54	2.5	94.6	4.0	3.5	6.0	4.5
E840	Inc. E640	36	78.7	3.6	5.0	6.5	7.5	8.0
Y047	Inc. Y947	52	11.8	78.6	6.0	5.5	6.0	7.0
Y048	Inc. Y948	52	16.4	74.5	5.0	5.0	6.0	6.5
Y049	Inc. Y949Rr	64	8.8	77.0	5.0	4.5	5.5	5.5
Y050	Inc. Y950Rr	67	9.3	79.9	4.0	3.0	6.0	5.0
Y051	Inc. Y951, 3Rr	41	18.2	61.9	5.0	4.0	6.0	6.0
Y052	Inc. Y952Rr	58	15.4	72.7	4.0	5.0	6.0	6.5
F80-37	Inc. E937	70	1.5	95.5	5.0	6.0	7.0	7.5
F79-36	Inc. C36 (79377)	47	4.9	89.5	5.0	6.5	7.5	8.0
917	Inc. 417	41	57.0	27.3	5.0	7.0	7.5	8.0
SELF-FERTILE LINES								
0201	ER 9230, 1, 2	34	9.3	76.5	4.0	5.0	4.0	5.0
0202	ER 9233, 4, 5, 6	33	12.2	69.7	4.0	5.0	5.0	6.0
0203	ER 9241, 2, 3	35	2.9	91.4	5.0	5.0	6.0	7.0
0204	ER 9747-1, 2, 3	38	6.0	78.9	5.0	5.0	6.0	6.0
0747	ER-YR 7747	57	11.4	77.8	6.0	6.5	7.0	6.5
0748	ER-YR 7748	60	9.1	80.4	6.0	7.5	8.0	8.0
8719	Inc. 6719	34	1.5	97.1	4.0	4.0	6.0	6.0
0717E	ER 8717⊗	34	0.0	100.0	4.0	4.0	6.0	7.0
0717M	BMVR 8717⊗	37	4.5	94.6	5.0	6.0	7.0	8.0
0719	ER 8719C1⊗	27	0.0	100.0	4.0	5.0	5.0	4.0
0719E	ER 8719⊗	26	0.0	100.0	3.0	4.0	5.0	6.0
0719AE	ER 8719C1⊗	30	2.0	93.3	3.0	4.0	5.0	7.0
0719BE	ER 8719BC1⊗	26	0.0	100.0	3.0	4.0	5.0	7.0
0719M	BMVR 8719⊗	26	0.3	96.2	2.0	3.0	5.0	6.0
0719A	Inc. 6719	28	2.1	92.9	3.0	3.0	6.0	6.0
0719C	Inc. 8719C1	28	3.9	92.9	4.0	4.0	6.0	4.0
917	Inc. 417	29	41.9	41.4	4.0	5.0	8.0	8.0
0720A	ER 8720C1⊗	24	15.2	70.8	2.0	3.0	4.0	6.0
0720B	NB-ER 8720C1⊗	27	20.2	66.7	3.0	4.0	5.0	6.0
0720E	ER 8720C1⊗	29	6.4	86.2	1.0	1.0	1.0	4.0
0721A	ER 8721C1⊗	26	7.3	73.1	4.0	6.0	7.0	8.0
0721B	NB-ER 8721C1⊗	24	51.2	25.0	4.0	5.0	8.0	8.0
0721E	ER 8721C1⊗	28	10.7	75.0	3.0	4.0	7.0	7.0
0722	NB-ER 8722C1	32	1.8	93.7	5.0	4.0	6.0	5.0
0722	ER 8722C1⊗	36	4.0	88.9	5.0	4.0	3.0	5.0
0722	Inc. 8722C1	31	13.8	67.7	5.0	4.0	5.0	7.0
0725	9751-1, ..., -14mm⊗	33	16.2	66.7	4.0	4.0	5.0	5.0
0780	PMRS 779⊗	29	35.9	41.4	1.0	1.0	1.0	2.0

TEST 2381-2. ERWINIA AND POWDERY MILDEW EVALUATION TEST, SALINAS, CA, 1981 (Continued)

F79-779	Inc. C779 (79435)	61	26.7	62.0	1.0	1.0	1.0	1.5
F79-779H0	C779CMS (79434)	64	33.0	59.3	2.0	1.0	1.0	1.5
9718	Inc. 3718 (C718)	62	13.2	77.9	7.0	6.0	6.5	7.0
9718H0	3718H0 x 3718	66	9.8	68.6	7.0	6.5	7.0	7.5
F78-546	Inc. F70-546 (78156)	54	1.9	90.4	4.0	5.5	7.5	7.0
0546	Inc. 9546E	67	1.6	94.1	3.0	4.5	6.0	7.5
0792	ER 8792⊗	23	0.4	95.7	2.0	3.0	7.0	5.0
0793	ER 8793⊗	36	5.4	86.1	4.0	4.0	5.0	5.0
0794	ER 8794⊗	26	9.7	73.1	7.0	7.0	5.0	8.0
0795	ER 8795⊗	19	7.9	68.4	6.0	7.0	7.0	8.0
0798	ER 8798⊗	28	16.6	53.6	2.0	3.0	4.0	4.0
0740	9740aa x A	61	10.7	81.2	6.0	5.5	7.0	8.0
0741	9741aa x A	62	6.8	77.1	6.0	6.0	7.5	8.0
0742	9742aa x A	51	7.8	86.2	4.0	4.5	5.0	4.5
0744	9744aa x A	62	13.9	77.1	4.0	4.5	5.0	6.0
0745	9745aa x A	53	8.3	77.6	6.0	6.5	6.0	6.5
0755	9755aa x A	55	6.0	85.3	3.0	3.5	3.5	3.5
0755	T-O-9755aa x A	45	7.8	80.1	3.0	5.0	4.0	5.0
0755-29A	Inc. 9755-29	40	10.5	75.2	6.0	6.5	6.5	6.0
0755-#EC1	ER 9755-#⊗	44	9.1	84.2	3.0	3.0	2.0	3.0
7755	6755aa x A	57	21.1	63.2	3.0	3.5	3.5	4.0
8755	7755Baa x A	55	4.1	92.8	3.0	3.0	3.0	3.0
9755	YR-ER 7755B (A,aa)	53	8.6	86.5	3.0	2.5	4.0	2.5
917	Inc. 417	64	23.2	50.1	4.0	5.5	7.0	8.0
0796-1	ER-YR 8796-1 (A,aa)	63	3.5	84.1	8.0	8.5	8.0	8.0
0796-2	ER-YR 8796-2 (A,aa)	50	4.3	83.2	6.0	7.0	7.5	8.0
F79-36	Inc. C36 (79377)	59	1.3	93.2	4.0	5.0	7.0	7.5
F78-546H3	562H0 x 546 (78155)	62	2.6	90.3	5.0	5.5	7.5	7.5
0546H3	562H0 x 9546E	70	2.5	90.0	5.0	6.0	8.0	8.0
0546H4	563H0 x 9546E	71	1.3	95.7	3.0	5.0	7.0	7.5
0546H26	779H0 x 9546E	75	4.4	92.0	3.0	3.5	5.5	6.0
0546H27	9758-1H0 x 9546E	70	8.9	79.8	6.0	6.0	6.5	7.0
0546H72	9718H0 x 9546E	66	6.3	76.7	7.0	6.0	7.0	7.5
0546HL7	8755H0 x 9546E	52	9.5	76.2	2.0	4.0	5.0	5.5
0546HL15	9755aa x 9546E	62	10.0	81.2	2.0	3.0	4.0	5.0
0758-1HL15	9755aa x 9758-1	54	16.5	72.8	3.0	4.0	4.0	3.5
0758-1H4	563H0 x 9758-1	51	8.4	66.6	3.0	4.5	6.0	6.0
0767H72	9718H0 x 9767E	49	8.4	73.4	4.0	5.0	6.0	7.5
0758-1	Inc. 9758-1 (C758)	47	34.8	29.2	2.0	4.5	6.0	6.0
0767-1	Inc. 9767E-1	41	21.0	39.8	4.0	5.5	6.5	7.5
0767-2	Inc. 9767E-2	29	12.6	48.1	4.0	4.5	5.5	5.0
8562	Inc. F66-562	40	18.1	38.0	5.0	5.5	7.0	7.5
8562H0	562H0 x 562	49	19.7	50.6	4.0	5.0	6.5	7.0

TEST 2381-2. ERWINIA AND POWDERY MILDEW EVALUATION TEST, SALINAS, CA, 1981 (Continued)

F80-566	Inc. 9563-30 (80420)	51	4.9	82.5	5.0	5.5	7.0	7.5
F67-563	Inc. 563	29	22.8	43.8	5.0	6.0	6.5	6.5
F67-563H0	563CMS x 563	53	10.0	67.5	4.0	6.0	6.5	7.5
F80-566CMS	9563-30H0 x 9563-30 (80418)	60	3.8	82.6	6.0	6.5	7.5	8.0
Yugo 1	4n MM NS-HL	25	37.4	44.0		2.0	1.0	1.0
2	4n MM NS-MBU	23	39.7	47.8		2.0	1.0	1.0
3	4n MM NS-KVM	14	15.7	78.6		1.0	1.0	1.0
4	4n MM NS-KVP	17	28.0	52.9		3.0	2.0	3.0
5	4n MM NS-G-65	23	33.5	56.5		2.0	1.0	2.0
6	4n MM NS-GM	20	18.5	75.0		2.0	2.0	1.0
7	4n MM NS-DM	25	18.0	72.0		3.0	2.0	4.0
8	4n MM NS-KR	19	20.3	78.9		1.0	1.0	1.0
9	4n MM NS-PZ	17	34.2	58.8		2.0	1.0	1.0
10	394 (T-O) 2n mm (NS)	18	4.7	88.9		6.0	8.0	7.0
11	394-4 (T-O) 4n mm (NS)	11	0.6	100.0		4.0	1.0	3.0
NS 358	Chinese 1 (L. Kovacev)	27	22.5	44.4		1.0	1.0	1.0
NS 359	Chinese 2 (L. Kovacev)	21	35.6	57.1		1.0	1.0	1.0

1/ See footnote 1, Test 2381-1
2/ See footnote 2, " "
3/ See footnote 3, " "

Note: Comparisons should primarily be made within sets of entries (denoted by dotted lines). A gradient in both severity of root rot and powdery mildew occurred down the field. Therefore, with only two replications, field variation was not removed. The level of root rot was relatively low in this test, but the DI's appear to accurately picture relative variety reactions. US H11 and F79-36 were entered as resistant checks and US H10B (917H8), 917 (C17), and E840 as susceptible checks.

SUGARBEET RESEARCH

1981 Report

Section B

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CONTENTS

I. EXPERIMENTAL FIELD TRIALS

J. C. Theurer & D. L. Doney

Agronomic Data

Soil Types:	North Farm - silty loam Farmington Farm - sandy Aberdeen - clay loam
Fertilizer:	950 lbs/acre of 16-20-0
Herbicides:	No chemical treatment was made for weed control in 1981
Planting Dates:	Farmington Farm - April 22 North Farm, Logan - April 28 Aberdeen, Idaho - April 15
Thinning Dates:	Farmington - May 28 - June 2 North Farm - June 5 - 9 Aberdeen - May 18-20
Irrigations:	Sprinkler irrigated at all locations until two weeks prior to harvest
Harvest Dates:	Farmington - October 5-6 North Farm - October 26-30 Aberdeen - October 19-21
Harvesting Procedures:	Tops were removed by beating twice with a rotobeater then topped and dug with a two-row harvester. Beets/plot were counted as they went into a weighing basket on the harvester. Two 10-beet samples were taken at random from each two-row plot for sugar analysis. All beets in each plot were weighed to determine root yield.

A. COMMERCIAL VARIETY TEST

Eighteen commercial hybrids, US22/3 and five Logan experimental varieties were planted at the North Farm in Logan in six replications. Individual plots were two rows wide, 56 cm apart, and 34 m long. An excellent stand was obtained, and little curly top was noted in the plots. Root yield, sucrose percentage, and impurity factors are listed in Table 1. Four varieties produced over 100 decitons per hectare gross sugar.

Beta 1237, ACH130, and Maribo Unica varieties were significantly better in sugar yield than 0145, the best Logan experimental. All commercial varieties except two were significantly superior to 0139, the lowest yielding experimental hybrid. Varieties highest in sugar yield were also those highest in root weight. Beta 1237 had the highest sugar percentage, being significantly

superior to all varieties except Hybrid 8 for this characteristic. Maribo Magnamono, Beta 9421, USH20A, AH14, and 0139 experimental had the highest impurity indicies.

B. EXPERIMENTAL VARIETY TESTS

Two experimental variety tests were planted at Aberdeen, Idaho, in 1981. GW-Mono-Hy-D2, which has been used as a standard check in our variety tests for the past five years, and four other high yielding commercial varieties, were used as checks in each experiment. In addition to the checks, Test 81-15 included 21, and Test 81-16 had 18 experimental hybrids. Individual plots were two rows, 35 feet (10.7 meters) in length, in six replications.

Results

Root yield, sucrose percentage, and total sugar yield of Test 81-15 is given in Table 2. One commercial variety was significantly better in sucrose yield than the seven experimental hybrids; otherwise, there was no difference between varieties for gross sugar. Root weight of the best experimental varieties was similar to that of the best commercial varieties. Five experimental hybrids, 0125, 0128, 28E47, 28E44, and 28E46, were significantly higher in sugar percentage than the best commercial variety. With the exception of 28E44, the experimentals that had low impurities were also the lowest in sugar yield. Only three of the experimental hybrids, 28E44 and 0125 with L19 parentage, and 0125 and 0152 with L10 parentage, showed promise for further evaluation.

Root yield, sucrose percentage, and sugar yield for varieties in Test 81-16 are shown in Table 3. Six experimental hybrids were equal to the highest yielding commercial varieties, and twelve experimentals were significantly lower in sugar yield. The extremely low yield of 0508 hybrid was due to a poor stand of only about 50 percent of the plants per plot as other entries. Hybrid 28E37 had the highest root weight. In addition, six other experimental hybrids equalled the best check variety in root weight. 14HS1, as expected, had significantly the highest sucrose percentage, but it was also one of the lowest in root yield. SP7155 X SP78564-0, 1314, 28E55, and 28E64 were other experimental hybrids having high sugar content. Inbred 1303 and hybrids 1310, 1314, 28E51, and 28E37 had the poorest impurity index values. Excellent general combining ability was noted for g237, a line selected for root yield and specific gravity, as indicated by its hybrids. Hybrids 28E62 and 28E37 are hybrids of a potential new source CMS crossed respectively with L37 and C17 inbreds. SP6926 X SP78564-0 also appears to have excellent specific combining ability for sugar yield with high root yield, relatively high sucrose percentage, and low impurities.

C. COMBINING ABILITY OF NEW LINES

Our seedling selection program generates many new lines, many of which are of little value. Most are highly heterozygous. Out of these lines, a number have shown some potential promise. This past year, we evaluated the combining ability of some of the most promising lines. All of the lines in Table 4 come

from population RRS2 and all of the lines in Table 5 come from population f354, except h537, which comes from population f356 (a selection out of a composite open-pollinated population).

Each line was crossed to three CMS testers (416 CMS, L53CMS, and R1CMS). The combining ability test of RRS2 selections was grown at Farmington, Utah (Table 4), and the test of f356 selections was grown at Logan, Utah (Table 5).

Most of the selections from the RRS2 population showed some heterosis for root yield (Table 4). Some of these hybrids looked rather good when compared to the check hybrids. The g237 line and its hybrids gave the best performance. This line has been tested in previous years and has consistently looked promising.

The lines from population f354 did not show much hybrid vigor. Their high heterozygosity may explain their lack of heterosis. The h532 line was a higher specific gravity selection than the h533 and h534 lines, and had a higher sucrose content. Selection for high specific gravity appeared to be effective in this population.

All selections were higher in impurity factors than the hybrid checks and the CMS testers. This was to be expected since selection was not practiced for impurity factors.

Table 1. Root yield, sucrose percentage, and impurity factors for commercial and experimental hybrids, Logan, Utah, 1980.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Amino N ppm	Na ppm	K ppm	Index	Root No.
Beta 1237	107.6	63.3	17.0	368	116	1485	461	67
ACH130	105.8	66.0	16.0	427	167	1804	585	66
Maribo Unica	105.2	66.6	15.8	404	162	1737	567	68
Beta 1839	102.7	63.8	16.1	431	175	1900	600	60
Maribo Magnamono	98.1	64.1	15.3	473	193	1877	660	67
Beta 9421	97.2	61.1	15.8	485	110	1920	654	65
Hybrid 8	97.1	59.3	16.4	448	106	1454	517	64
USH20A	96.6	62.3	15.5	546	163	1633	652	67
GWD2	96.6	59.4	16.2	431	78	1560	535	66
GW149	96.4	61.5	15.7	476	88	1581	576	68
Hilleshog 309	95.2	60.5	15.7	414	190	1725	578	64
USH23	94.4	61.8	15.2	450	120	1479	566	68
GWR1	93.0	58.8	15.9	483	88	4139	550	67
USH11	92.1	58.0	15.9	475	83	1775	597	63
TASCO 5376-02	92.0	58.4	15.8	382	73	1555	505	65
0145	91.7	61.1	15.0	436	113	1745	608	68
Maribo Monova	90.6	56.7	16.0	487	176	1789	624	57
AH14	88.9	57.9	15.3	515	101	1777	648	67
0162	86.7	55.2	15.7	345	151	1245	453	66
0137	86.6	56.7	15.3	409	133	1681	571	63
Hilleshog 838	81.8	52.2	15.6	373	127	1691	539	57
0164	81.3	52.5	15.5	416	133	1400	526	62
US22/3	77.6	50.5	15.4	470	115	1568	586	59
0139	77.4	54.5	14.2	466	73	1679	643	58
F Ratio	3.2**	2.4**	3.4**	4.1**	10.3**	6.2**	7.4**	1.2 ns
LSD 0.05	12.8	7.6	0.8	66	32	192	59	9
CV	12.2	11.2	4.5	13.1	22.7	10.3	9.0	12.6
Mean	93.0	59.2	15.7	443	127	1646	576	64

Table 2. Root yield, sucrose percentage, gross sugar yield, and quality factors for experimental hybrids, Aberdeen, Idaho, 1981

Variety	Gross sugar dt/ha	Root yield t/ha	Sucrose %	Amino N ppm	Na ppm	K ppm	Impurity Index
GWH149	149.7	98.6	15.2	691	300	2784	986
Hilleshog 309	146.6	98.4	14.9	600	545	2631	979
28E44	143.6	80.0	18.0	579	328	2700	762
0125	142.7	84.2	17.0	717	390	2568	883
0152	140.2	89.3	15.7	584	288	2462	829
0126	137.7	89.5	15.4	612	481	2840	969
GWD2	135.3	86.9	15.6	562	270	2525	828
0160	131.3	81.1	16.1	570	307	2150	756
0157	130.3	81.1	16.1	452	354	1893	656
28E46	129.8	75.9	17.1	572	254	2465	748
0135	128.8	85.2	15.2	524	224	2537	821
TASCO 3576-02	127.6	81.3	15.8	615	279	2803	898
0142	127.0	90.7	14.0	638	347	2596	1013
28E47	127.0	72.2	17.6	576	363	2659	779
0144	126.7	83.6	15.2	603	287	2709	911
0127	126.3	78.9	16.0	639	320	2453	858
Beta 9421	126.2	85.2	14.8	691	300	2975	1042
0161	125.7	76.9	16.4	473	285	2118	677
0145	125.3	86.8	14.5	572	278	2609	920
0154	123.9	76.9	16.1	538	360	2131	747
0139	122.8	86.4	14.3	580	275	2878	989
0133	122.4	80.5	15.2	526	194	2709	838
0128	121.8	70.6	17.2	554	265	2309	714
0151	119.4	74.2	16.1	526	285	2121	719
0134	111.7	77.3	14.4	539	356	2800	952
0165	106.3	67.9	15.6	595	305	2193	803
F Ratio	3.0**	5.0**	6.2**	1.6ns	3.9**	8.0**	4.0**
LSD 0.05	15.9	9.4	1.1	135	103	277	154
CV	8.9	8.1	5.2	16.9	23.5	7.8	12.9
Mean	129.1	82.3	15.7	582	317	2524	849

Table 3. Root weight, sucrose percentage, gross sugar yield, and quality factors as experimental varieties, Aberdeen, Idaho, 1981.

Variety	Gross sugar dt/ha	Root weight t/ha	Sugar %	Amino N ppm	Na ppm	K ppm	Impurity Index
Hilleshog 309	163.4	98.0	16.7	407	266	2528	680
SP6926 X SP78564-0	155.1	91.2	17.0	247	134	2050	472
GWH149	153.7	92.6	17.1	447	149	2243	626
GWD2	151.4	86.7	17.2	384	169	2150	570
28E64	150.7	87.4	17.4	473	188	2150	623
Beta 9421	150.4	88.4	17.0	464	182	2312	654
28E37	149.9	101.1	15.5	345	204	2568	699
416CMS X g237	148.5	88.3	17.2	432	222	2237	624
L53CMS X g237	148.4	88.3	16.9	476	330	2468	723
TASCO 5376-02	142.6	81.7	17.2	415	140	1984	560
28E54	142.0	85.5	16.9	422	277	2396	667
28E62	141.8	84.1	17.2	372	150	2096	556
28E63	137.6	84.0	16.6	367	138	2234	588
28E55	137.6	82.7	17.5	380	223	2412	611
R1CMS X g237	134.8	77.5	17.8	462	212	2243	621
g237	134.7	83.2	16.3	487	260	2568	750
FC606 X SP78564-0	134.7	80.8	16.9	398	143	1775	527
SP71550-01 X SP78564-0	134.1	74.9	18.2	370	84	1753	465
28E51	129.3	88.1	15.4	302	413	2734	747
EL45 X SP78564-0	122.5	75.3	16.7	534	241	2143	698
FC506 X SP78564-0	113.8	69.4	16.2	334	165	1906	534
14IHS	94.1	48.2	19.6	430	78	1731	455
0508 (Bulk)	51.8	35.2	14.8	389	242	2693	783
F Ratio	9.54	10.0**	4.45**	1.67ns	5.12**	6.06**	3.50**
LSD 0.05	21.5	13.1	1.3	141	96	330	140
CV	9.7	9.7	5.4	24.6	34.0	10.5	16.0

Table 4. Combining ability of four new lines for total sucrose, root yield, percent sucrose, and three impurity factors (N_3, Na, K).

	Total sugar dt/ha	Root yield t/ha	Sucrose %	N ppm	Na ppm	K ppm	Index	Selection Parameter (Pop. RRS2)
416CMS X G232	95.3	61.9	15.4	394	226	2054	644	
L53CMS X g232	95.2	64.0	15.2	363	246	1956	618	
R1CMS X g232	99.1	63.1	15.7	313	257	1912	563	
Mean	96.5	63.0	15.4	357	243	1974	608	
g232	85.3	59.3	14.5	424	308	2389	789	Hypocotyl diameter
416CMS X g237	97.8	59.2	16.5	344	188	2145	574	
L53CMS X g237	107.4	71.7	15.0	395	248	2108	675	
R1CMS X g237	115.7	71.0	16.3	389	260	2143	622	
Mean	107.0	67.3	15.9	376	232	2132	623	
g237	96.6	63.6	15.2	365	287	2314	688	Root weight and specific gravity
416CMS X g239	98.8	62.2	16.0	314	170	2058	560	
L53CMS X g239	91.4	65.8	13.9	394	299	1970	721	
R1CMS X g239	101.5	63.6	16.0	310	271	2122	585	
Mean	97.2	63.9	15.3	339	246	2050	622	
g239	84.1	60.5	13.8	427	374	2695	897	Root weight and specific gravity
416CMS X g242	88.0	56.3	15.6	378	242	2339	675	
L53CMS X g242	106.3	70.1	15.2	436	338	2533	780	
R1CMS X g242	96.7	62.2	15.5	398	340	2318	706	
Mean	97.0	62.9	15.4	404	307	2396	720	
g242	87.8	59.3	14.9	544	336	2516	871	Hypocotyl diameter
GWD2	94.7	60.1	15.9	369	134	2079	589	
TASCO 3576-02	99.7	64.9	15.3	266	168	1916	526	
LSD 0.05	15.9	9.6	1.1	99	91	260	117	(between individual entries)
LSD 0.05	13.0	7.8	0.9	81	75	212	95	(between mean of hybrids and parent)

Table 5. Combining ability of five new lines for total sucrose, root yield, percent sucrose, and three impurity factors (N, Na, K).

Description	Total sucrose dt/ha	Root yield t/ha	Sucrose %	N ppm	Na ppm	K ppm	Index	Selection Parameters
416CMS X h532	102.8	64.1	16.0	487	137	1827	621	
L53CMS X h532	91.8	59.3	15.5	589	215	1947	741	
R1CMS X h532	107.9	65.6	16.5	570	183	1897	675	
Mean	100.8	63.0	16.0	549	178	1890	679	
h532	98.1	64.7	16.2	560	242	2297	804	SG in Pop f354
416CMS X h533	104.4	65.2	16.0	515	144	1810	636	
L53CMS X h533	99.3	62.3	16.0	584	183	1735	678	
R1CMS X h533	105.3	65.2	16.1	557	159	1787	656	
Mean	103.0	64.2	16.0	552	162	1777	657	
h533	97.3	63.7	15.3	644	200	2207	827	SG in Pop f354
416CMS X h534	93.7	38.6	16.0	481	118	1645	585	
L53CMS X h534	102.5	65.4	15.5	502	174	1735	645	
R1CMS X h534	97.1	64.6	15.0	535	185	1956	725	
Mean	97.9	62.9	15.5	506	159	1779	652	
h534	105.5	68.2	15.5	529	266	2120	745	SG in Pop f354
416CMS X h544	90.4	56.6	16.0	602	123	1777	684	
L53CMS X h544	95.1	58.5	16.3	581	152	1681	648	
R1CMS X h544	104.4	64.1	16.3	533	155	1789	638	
Mean	96.6	59.7	16.2	572	143	1749	657	
L544	96.9	63.3	15.4	532	167	2040	720	Hypocotyl diameter in Pop f354
416CMS X h537	95.7	61.8	15.5	558	131	1872	692	
L53CMS X h537	98.4	65.5	15.0	587	186	1912	756	
R1CMS X h537	106.6	71.5	14.9	503	196	2037	725	
Mean	100.2	66.3	15.1	549	171	1940	724	
h537	105.7	72.6	14.6	602	233	2252	859	SG in Pop f356
GWD2	111.6	70.1	16.0	516	82	1770	619	
TASCO 3576-02	101.1	63.1	16.0	501	117	1735	612	
LSD 0.05	9.5	5.7	0.8	86	38	184	78	(between individual entries)
LSD 0.05	7.6	4.6	0.6	67	30	148	63	(between mean of hybrids & parents)

II. FIELD SELECTION OF 70-DAY OLD SUGARBEET PLANTS

J. C. Theurer

Studies of the early growth of the sugarbeet have shown that most of the available photosynthate is utilized for leaf development during the first few weeks of ontogeny. At approximately 25 to 30 days growth, all of the cambial rings of the root have been developed and the root begins to become the dominant sink for photosynthate. In our location, leaf area increases until the middle of August, after about 100 days growth, then begins to decrease. The greatest rate of root growth and dry matter accumulation occurs at this time also. The period of greatest rate of sucrose accumulation on a fresh root basis occurs slightly earlier, at approximately 70 days growth. Data from these studies suggested that selection at 70 days could be a means of developing superior genotypes.

In 1979, we initiated an experiment to determine the effectiveness of field selection for high root yield and sucrose percentage at 70 days growth. This is a report of results obtained from selections in three populations.

Materials and Methods

Three heterogeneous populations of sugarbeet, two developed at Logan, and one developed at Salinas, Calif., were utilized for selection. These populations were each planted in large field selection blocks of approximately one-twelfth acre (.03 ha) size. Seed was planted in 22-inch (56 cm) rows and the plants were meticulously thinned to a single plant 12 inches (30 cm) apart when plants were in the 4-leaf stage of development. The outside plot rows were bordered by two rows of a commercial variety. The roots were dug by hand after 70 days growth. The two beets on the ends of each row were discarded. The first linear 100 beets were used to estimate the variation in each population. Thereafter, only the larger roots were harvested.

Each root was immediately weighed after the removal of petioles and leaves. Each root having a root weight greater than the mean of the 100 beets was cut in half longitudinally. One-half was shredded and used for sucrose percentage determination by the cold digestion process. The other half was placed in cold storage for photothermal induction. Roots exceeding 1 sd greater than the mean for both root weight and sucrose percentage were selected in one group (HYHS), and roots with a weight exceeding 1.5 sd greater than the mean with sugar content equal to or above the mean were selected in a second group (HY).

In the summer of 1980, each selection group and the parent population was increased in separate garden isolation plots with a series of CMS inbreds. The open-pollinated and hybrid progenies of the parent and the HYHS, and HY selections for each population (C789, 36D1, and 6F3) were evaluated in replicated field tests in 1981. The C789 and 36D1 groups were planted at the Farmington Farm. The 6F2 population was planted at Logan. Each test consisted of 2-row plots, 35 feet long, in six replications of a randomized block design. At Farmington, we experienced a problem with stand establishment and some of the plots were not representative enough to be valid for root weight harvest data.

Results and Discussion

Root yield, sucrose percentage, total sugar yield, and impurity factors for the 6F2 populations are listed in Table 1. Significant differences were noted for all measured characteristics with the exception of impurity index. However, this significance was mainly due to the specific effects of some crosses, e.g., R2 X 6F3HY, and E36 X 6F3HYHS. There were no differences in the means of the HYHS and HY selections and the parent open-pollinate populations or hybrids with six different male sterile inbreds. Thus, field selection in this population was ineffective.

The performance of selections made in the 36D1 population is given in Table 2. Significant differences were noted for all measured characteristics except Amino N. Hybrid combinations, F6 X HYHS, EL36 X HY, C16 X HY, and L10 X HY had the highest total sugar yield. Open-pollinated progenies of the HYHS and HY selections showed slightly higher sugar yield and root weight than the parent OP; however, significance was noted only for root yield for HYHS OP. The parent OP had significantly higher sugar percentage and there were no differences between the OP progenies for impurity index. HYHS hybrids showed better general combining ability than HY hybrids for total sugar and root weight. HYHS and HY hybrids averaged significantly higher sucrose percentage, and impurity index than parent hybrids. It was noted, however, that the HY hybrids had better combining ability for sucrose percentage than did HYHS where selection was made for high sucrose percentage. Thus, selection at 70 days growth in this population was slightly effective for root yield, ineffective for sucrose percentage, and no change was realized in impurity index values.

Root yield, sucrose percentage, total sugar yield, and impurity factors for open-pollinated lines and hybrids from population C789 are listed in Table 3. Significant differences were obtained for all factors that were measured except for Amino N. HYHS OP had lower root yield, sucrose percentage, and sugar yield than the parent population. A comparison of the combining ability of the parent and the HYHS and HS selections when crossed to C16CMS, L53CMS, and R2CMS females showed slightly higher root weight, but lower sucrose percentage for the HYHS and HY selections versus the parent. There was no difference in the total sugar yield or impurity factors for combining ability.

Summarizing the observations from the three experiments, we would have to conclude that field selection after 70 days growth was not effective in any of the populations in improving sugar percentage. In two of the populations (6F3 and 36D1) there was a trend for increasing root weight by selecting larger roots (HY) and a further increase when selection was also made for sugar content (HYHS). However, these differences in root weight were non-significant when compared to the parent population. The HYHS and HY selections showed no improvement in combining ability over the parent when tested with several diverse CMS inbreds.

Since all three populations are highly heterogeneous, one would expect that the potential of selecting superior genotypes would be good. The fact that selection was not effective is indicative that there was too much environmental variation present to isolate superior genetic segregates. Thus, we would not recommend this method as a selection tool.

Table 1. Root yield, sucrose percentage, total sugar yield and impurity factors for 6F3 parent, HYHS and HY open-pollinated and hybrid progenies, Logan, Utah, 1981.

	Total sugar dt/ha	Root yield t/ha	Sucrose %	Amino N ppm	Na ppm	K ppm	Impurity Index
6F3 HYHS OP	100.1	63.3	15.8	595	145	1804	694
E36 X 6F3 HYHS	103.0	68.1	15.1	532	195	1906	712
C16 X 6F3 HYHS	88.4	58.8	15.1	604	158	2118	791
L53 X 6F3 HYHS	86.2	55.7	15.5	677	192	1687	757
F6 X 6F3 HYHS	82.9	53.8	15.4	591	161	1825	718
R2 X 6F3 HYHS	95.5	57.8	16.5	613	196	1722	675
L10 X 6F3 HYHS	92.3	59.5	15.5	504	157	1814	656
6F3 HY OP	99.0	62.7	15.8	644	183	1995	763
L36 X 6F3 HY	89.4	58.9	15.2	555	202	1943	737
C16 X 6F3 HY	92.8	62.3	14.9	594	161	2241	817
L53 X 6F3 HY	94.8	62.3	15.2	672	201	1860	796
F6 X 6F3 HY	88.7	56.4	15.7	485	132	1929	645
R2 X 6F3 HY	113.7	70.2	16.2	631	159	2047	742
L10 X 6F3 HY	99.6	64.6	15.5	554	161	1762	700
6F3 Parent OP	94.4	62.3	15.1	557	173	2031	745
L36 X Parent OP	88.6	60.2	14.7	622	211	2154	847
C16 X Parent OP	96.3	63.6	15.1	554	173	2254	779
L53 X Parent OP	95.6	59.6	16.1	615	145	1756	688
F6 X Parent OP	93.4	56.6	16.5	506	136	1843	618
R2 X Parent OP	96.0	61.3	15.7	601	159	1968	734
L10 X Parent OP	99.0	62.6	15.8	455	163	1797	608
GWD2	97.8	62.0	15.8	596	96	1747	676
Beta 9421	91.0	60.4	15.0	731	131	2114	869
F Ratio	2.5**	2.3*	2.3*	2.0*	4.0**	2.8**	1.6ns
LSD 0.05	11.0	6.8	1.1	124	38	270	155
CV	10.2	9.8	6.0	18.6	20.3	12.3	18.6
Mean	94.9	61.0	15.5	587	164	1927	736

Table 2. Root yield, sucrose percentage, total sugar yield, and impurity factors for 36D1 parent, HYHS, and HY, open-pollinated and hybrid progenies, Farmington, Utah, 1981

	Total sugar dt/ha	Root yield t/ha	Sucrose %	Amino N ppm	Na ppm	K ppm	Impurity index
36D1 HYHS OP	99.5	66.3	15.3	317	168	1956	567
EL36 X HYHS OP	100.1	63.5	15.7	291	190	1937	536
C16 X HYHS OP	93.8	64.2	14.6	340	201	2318	678
L53 X HYHS OP	95.1	62.5	15.2	317	198	1716	537
F6 X HYHS OP	110.1	70.3	15.7	281	185	1979	537
R2 X HYHS OP	109.5	68.1	16.1	337	178	1925	547
L10 X HYHS OP	96.9	61.8	15.7	230	258	1851	501
36D1 HY OP	94.5	61.1	15.4	290	181	1841	528
EL36 X HY OP	112.6	71.7	15.7	265	258	1900	530
C16 X HY OP	113.6	74.5	15.3	298	191	2102	586
L53 X HY OP	95.1	58.3	16.3	336	175	1856	530
F6 X HY OP	102.9	66.1	15.6	343	223	2043	600
R2 X HY OP	106.0	64.8	16.4	333	220	2012	560
L10 X HY OP	110.9	70.3	15.8	318	173	1845	535
36D1 X Parent OP	91.8	56.1	16.4	321	194	1995	544
EL36 X Parent OP	102.7	68.4	15.0	316	244	2085	616
C16 X Parent OP	97.9	65.8	14.9	286	191	2226	614
L53 X Parent OP			14.0	300	211	2229	666
F6 X Parent OP			14.9	298	215	2183	621
R2 X Parent OP			15.3	332	283	1995	608
GWD2	119.2	73.7	16.2	305	80	2012	518
F Ratio	3.3**	3.8**	3.7**	1.0ns	3.6**	3.4**	2.2*
LSD 0.05	12.3	7.2	0.9	78	61	226	92
CV	10.5	9.5	4.9	22.5	26.7	10.0	14.3
Mean	102.9	66.0	15.5	307	201	2001	570

Table 3. Root yield, sucrose percentage, total sugar yield, and impurity factors for C789 parent, HYHS, and HY open-pollinated and hybrid progenies, Farmington, Utah, 1981.

	Total sugar d/ha	Root yield t/ha	Sucrose %	N ppm	Na ppm	K ppm	Impurity index
C789HYHS OP	65.4	45.9	14.2	490	156	1731	688
EL36 X HYHS				502	280	1989	821
C16 X HYHS	94.3	68.3	13.8	443	190	1966	727
L53 X HYHS	93.2	66.5	14.8	535	217	1547	674
R2 X HYHS	96.4	67.7	14.3	388	235	1683	626
C789 HY OP				440	221	1841	739
EL36 X HY				547	264	2056	848
C16 X HY	90.5	67.7	13.4	460	238	2106	801
L53 X HY	88.9	60.0	14.8	454	250	1664	641
R2 X HY	100.0	67.1	14.9	434	267	1727	645
C789 Parent OP	71.5	48.3	14.8	482	146	1868	680
EL36 X Parent	83.5	58.9	14.1	420	201	1877	681
C16 X Parent	90.8	61.8	14.7	483	196	1993	717
L53 X Parent	99.9	65.9	15.2	478	233	1697	639
R2 X Parent	93.9	61.1	15.4	482	225	1856	666
GWD2	125.3	81.6	15.3	555	134	1710	674
Beta 9421	109.9	75.1	14.7	404	182	1943	649
F Ratio	2.5**	11.1**	4.0**	1.6ns	3.8**	4.2**	3.1**
LSD 0.05	12.3	3.51	.93	107	61	16	107
CV	11.5	10.7	5.6	19.8	25.0	10.2	13.3
Mean	93.1	29	14	471	214	1839	702

III. PHYSIOLOGICAL SELECTION

Devon L. Doney

A. Background

The negative correlation between root yield and sucrose content has caused significant constraints in potential breeding progress. Our past research has discovered the physiological reason for this relationship to be due to opposite effects of cell size on yield and sucrose content, i.e., large-celled genotypes are high in root yield and low in sucrose content and vice versa. In addition, genetic differences in cell size are due largely to additive gene effects, whereas genetic differences in cell number are due largely to non-additive gene effects.

In order to utilize this information to his advantage, the breeder must be able to identify genetic differences in both cell size and cell number. Normal breeding practices capitalize on both, with genetic differences in cell size predominating. However, the most desirable situation would be to capitalize on cell number while maintaining small cells.

Determining these parameters microscopically is not only difficult but time consuming. Therefore, we have embarked on a research effort to identify those cellular parameters using alternate easily-measured, highly correlated seedling parameters. This year's research involved the field testing of several of these parameters. Each of the selection parameters were based on theory and specific assumptions. However, as can be seen in the following report, some of the assumptions may not have been valid.

B. Selection for Seedling Hypocotyl Diameter, Percent Dry Matter, and Total Dry Matter

Hypocotyl diameter has been shown to be effective in increasing root yield; however, this increase has generally been accompanied by decreases in sucrose content. It was found that these results were largely due to selection for larger cells. It is, therefore, necessary to include other selection criteria that will identify young cells.

It was assumed that in small plants (3-week-old seedlings) there were few, if any, genetic differences in sugar content, non-sucrose soluble solids, and cell wall thickness. If these assumptions are valid, then the root percent dry matter would be a relative measure of cell size, which would then relate to sucrose content. The total root dry matter would, therefore, relate to total sucrose production. These selection criteria, coupled with hypocotyl diameter, should increase root yield, sucrose content, and total sucrose yield.

Selections for these three parameters were made in four different broad-base populations. Selection was via recurrent selection based on progeny test results. Only two to six beets for each selection survived to produce seed. This was insufficient seed for field testing; therefore, a seed increase of each selection was obtained the following year (1980) in isolation tents.

1. Selections in Population h8: Twelve selections varying in hypocotyl diameter, percent dry matter, and total dry matter were chosen in this population. Each selection was initiated from only two plants; therefore, some imbreeding depression could be present. The results are summarized in Table 1.

Table 1. Root yields, total sucrose, and percent sucrose for selections for seedling hypocotyl diameter, percent dry matter, and total dry matter in population h8.

	Total sucrose dt/ha		Root yield t/ha		Sucrose %
Parent (h8)	102.1		68.2		15.0
High dry weight	94.7	High HD	64.9	High % dry wt.	14.8
Low dry weight	88.5	Low HD	60.9	Low % dry wt.	14.5
LSD 0.05 (Between parent & sel)	9.5		6.0		0.5
LSD 0.05 (Between selections)	5.5		3.5		0.3

Hypocotyl diameter, dry weight, and percent dry weight of seedlings were all effective in selection for root yield, total sucrose, and percent sucrose; i.e., the high selections were significantly higher than the low selections. No selection exceeded the parent, but the low selections were significantly below the parent. This points out the difficulty of increasing both yield and quality. Negative selection is possible, but positive selection is very difficult. These data suggest the presence of inbreeding depression, or the vigor of the original population (h8) was so great that it is very difficult to find combinations that will exceed it.

2. Selection in Population h479: Five selections were made in this population in a manner similar to those in population h8. The number of plants in each selection varied from 2 to 6. There were insufficient seed of the parent for field testing; therefore, comparisons between the parent and selections are unavailable. A summary of the data are presented in Table 2.

Table 2. Total sucrose, root yield, and percent sucrose for selections varying in hypocotyl diameter, dry weight, and percent dry matter of h479 seedlings.

	Total sucrose dt/ha		Root yield t/ha		Sucrose %
High dry weight	85.6	High HD	60.2	High % dry wt.	14.1
Med dry weight	94.3	Med HD	67.8	Low % dry wt.	15.0
LSD 0.05	6.7		5.2		0.7

In this test, the high selections were significantly lower than the medium to low selections for all three characters. These results are directly opposite those reported for population h8. This suggests that selections were random deviates and not true genetic deviates.

3. Selections in Population h537: This population is more heterozygous than the two previous populations. Selections were for only two parameters: high total dry weight and high percent dry weight. Results are given in Table 3.

Table 3. Total sucrose, root yield, and percent sugar for the parent (h537) and two selections.

	Total sucrose dt/ha	Root yield t/ha	Sucrose %	Beet number
Parent (h537)	95.7	69.2	13.8	61
High total dry weight	80.7	60.1	13.5	51
High percent dry weight	81.7	55.2	14.8	45
LSD 0.05	7.6	5.2	0.7	9

The selection for high percent dry weight showed a significant increase in sucrose content and a significant reduction in root yield. In fact, both selections yielded significantly less than the parent. Poor stands for the two selections may explain the lower root yields.

4. Selection in Population 2NOP: Five selections differing in these three parameters were made in population 2NOP. Selections originated from 2 to 4 beets each. It was very difficult to find selections high in both HD and percent dry matter. We had to settle for several selections in the medium range. In each category, the medium or low selection was the lowest, while the high selections were the highest (Table 4). The results tended to show a positive selection pressure. The most positive results were for percent dry weight where a good correlation between seedling percent dry weight and sucrose content was obtained.

Table 4. Total sucrose, root yield, and percent sucrose of seedling selections varying in hypocotyl diameter, dry weight and percent dry weight.

Selection	Seedling dry wt.	Total sugar dt/ha	Seedling HD	Root yield t/ha	Seedling % dry wt.	Sucrose %
1228	High	73.8	High	49.6	High	14.9
1284	High	68.2	High	50.5	Low	13.5
1232	Med	62.1	Med	45.5	Med	13.7
1251	High	73.5	High	52.3	Med	14.1
1271	High	73.8	High	52.3	Med	14.2
LSD 0.05		9.7		6.4		0.8

The results of these four tests, while somewhat conflicting, generally showed positive results. Good environmental control in the seedling testing stage is essential. Some of the conflicting results may be due to the fact that environmental variation is so great that true genetic deviates cannot be detected. Another reason for the different or not too positive results may be that one or more of the original assumptions are incorrect. A report on an evaluation of these assumptions is given in a following section "Evaluation of Seedling Selection Parameters."

C. Selection for Hypocotyl Diameter (HD) at 6 and 21 Days of Age

Selection for HD at 21 days of age has been shown to exert selection pressure on both cell size and cell number. It was found that all genotypes lay down the same number of rows of cortex cells in newly emerged hypocotyls, but that there were differences in cortex cell size. These differences in cortex cell size were due to seed quality and genetics. Much of the effect due to seed quality could be eliminated by evaluating seeds of the same size. It was, therefore, assumed that differences in HD at 6 days of age would reflect differences in cell size. HD of 6-day-old seedlings ranges from 22/1000 to 45/1000 inches. Correlations between HD of 6-day-old seedlings and sucrose percent averaged about -0.6. We, therefore, initiated selection for HD of 6-day-old plants between individual plants and between lines. The between-lines selections also included selection for HD at 21 days of age. We concluded that if we could determine the genetic cell size potential at 6 days, then differences in HD at 21 days could be identified as to the source (cell size or cell number). The most ideal parameters being: small HD at 6 days and large HD at 21 days.

1. Selection Between Plants: Selection of individual plants for large and small HD of 6-day-old plants was conducted in population f354. This population has fairly good yield and quality and should be somewhat heterozygous. The selected plants for each selection (large and small HD) were placed in an open-pollinated polycross to produce seed. Field results of these selections are given in Table 5.

Table 5. Total sucrose, root yield, and percent sucrose of large and small hypocotyl diameter selections of 6-day-old plants.

	Total sucrose dt/ha	Root yield t/ha	Sucrose %
Parent (f354)	106.8	68.7	15.5
Large HD at 6 days	99.0	66.1	15.0
Small HD at 6 days	112.8	72.4	15.6
LSD 0.05	14.2	8.2	0.9

The effect of HD of 6-day-old plants on sucrose percent appeared to follow the theoretical trend; i.e., the small HD selection was higher and the large HD selection was lower in percent sucrose than the parent; however, differences were not significant. Poor seed production of the large HD selection resulted in a poor beet stand and may account for the lower root yield of this selection. These results

are positive but not significant enough to confirm this theory.

2. Selection Between Lines: The amount of environmental variation on an individual plant is so great that genetic differences are very difficult to detect. Therefore, selection was carried out between lines where 30 to 40 plants could be evaluated for each line. From a series of 50 lines, six lines were selected with differing values for HD at both 6 and 21 days. A new open-pollinated seed generation was produced of each of the selected lines and the lines reevaluated. Thus, selections made because of seed quality or random environmental effects could be detected.

   The HD of 21-day-old seedlings gave the same relationships in the new seed generation as the old seed generation indicating that the initial evaluations were true genetic differences (Table 6). The HD readings of 6-day-old plants in the new generations, in general, was similar to that of the old seed generations. The exception to this was line f675. The big change in reading between the new and old seedlots of this line was probably due to seed quality.

   Seedling measurements generally gave positive field results. The large HD selection at 6 days had the lowest sucrose content and the smaller HD lines gave higher sucrose percentages. The large HD lines of 21 days gave the highest root yields and the small HD lines at 21 days yielded less. The one exception to this again was the f675 line. These results suggest that selection for HD at 6 and 21 days can give positive results if the tests are carefully controlled to eliminate effects due to environment and seed quality.

Table 6. Total sucrose, root yield, and percent sucrose and the old and new seed generation reading of hypocotyl diameter at 6 and 21 days of six lines.

	Hypocotyl diameter				Total sucrose	Root yield	Sucrose
	6 days		21 days				
	Old seed	New seed	Old seed	New seed	dt/ha	t/ha	%
f681	35.0	30.6	large	large	119.9	80.7	14.8
f701	28.1	27.8	small	small	105.8	67.6	15.7
f700	31.3	27.4	small	small	107.5	69.9	15.4
h541	29.0	28.8	small	small	110.2	67.8	16.3
h542	30.4	27.1	large	large	112.0	70.3	15.9
f675	37.8	28.8	large	large	100.6	64.9	15.5
LSD 0.05	0.8	0.8			14.2	8.2	0.9

D. Selection for Seedling Genotypic Competition

Past research has shown that both competitive ability (ability to excell under severe compeition) and competitive influence (influence on neighbors) are important in commercial field production. Extreme difficulty was encountered in measuring these parameters in the field. Therefore,

an attempt was made to measure and select for these two parameters in carefully controlled greenhouse experiments. One seed of each competing genotype was planted in the center of a one and one-half inch diameter pot. Four seeds of a common competitor were planted around the outside of each pot. At four weeks of age, all plants were weighed and the competitive ability and competitive influence of each competing genotype determined. Selections were made for competitive ability and competitive influence based on plant weight. All plants of a like selection parameter were placed in an isolator to produce seed for testing. Unfortunately, only two selections produced enough seed for testing. Field observations revealed that the two selections were much more genetically uniform than the parent population.

From previous research, the most desirable selection would be one with a positive competitive influence and ability. Unfortunately, most genotypes that gave a positive competitive ability had a negative competitive influence. Therefore, we had to be satisfied with having a mean competitive influence effect for one selection. Both selections outyielded the parent; however, both selections were significantly lower in percent sucrose than the parent (Table 7). The result was no change in total sugar production. This selection pressure resulted in a change in photosynthetic partitioning rather than an increase in photosynthate. Apparently the larger plant fresh weight was due to water rather than dry matter or photosynthate.

Table 7. Total sucrose, root yield, and percent sucrose for two selections for seedling competitive ability and competitive influence.

	Selection Parameter		Total sucrose	yield	Sucrose
	Competitive influence	Competitive ability	dt/ha	t/ha	%
Parent (h537)			96.4	67.9	14.2
1243	$\bar{x}$	>1 SE	90.1	75.2	12.0
1265	>1 SE	>1 SE	91.2	77.0	11.8
LSD 0.05			14.2	8.0	0.9

E. Evaluation of Seedling Selection Parameters (D. L. Doney & Guenter Diener)

Because of inconsistencies in the results of seedling selection, as reported in the above section, we have investigated these selection criteria more thoroughly. In addition, we developed a method of determining seedling specific gravity. Since specific gravity and percent dry weight are closely related, this would give a means of determining relative cell size without destroying the plant. This, however, depends on the theory that percent dry weight is highly correlated to seedling cell size.

Four commercial hybrids varying in root yield and sucrose concentration potential were tested in a series of repeated seedling tests. These same hybrids had also been included in various replicated field trials over the past five years at Logan, Utah. Comparisons were made of their mean performance over the past five years with their mean seedling performance.

To eliminate years and test effects, data are presented as percent of check, using GWD2 as the check (Table 8). The seedling data was fairly consistent over tests; i.e., the ranking of the hybrids for each of the measurements were about the same for each test. The seedling fresh root weight, dry root weight, and hypocotyl diameter all corresponded fairly well with harvest root yield. The hypocotyl diameter showed the best relationship with root yield and seedling dry weight correlated best with total sugar. The percent dry weight and specific gravity did not, however, correlate well with the field results for sucrose content. The only hybrid that showed some consistent relationship was ACH14. This hybrid had the highest percent sucrose and the highest percent dry matter and specific gravity. The other hybrids showed very little relationship between field and seedling data. This suggests that seedling percent dry matter and specific gravity are reliable for some specific genotypes but not for the majority of genotypes. Therefore, the original assumptions underlying the use of these seedling parameters must be reevaluated.

Table 8. Field data averaged over five years and seedling data averaged over five tests for four commercial hybrids. Data are reported as percent of the GWD2 check.

	Field Tests			Seedling Tests				
	5-year average as % of check			5-test average as % of check				
	Total sugar	Root yield	Sucrose %	Fresh wt.	Dry wt.	HD	Dry wt. %	SG
GWD2	100	100	100	100	100	100	100	100
USH10	89	96	93	82	89	97	109	105
ACH14	72	71	103	63	72	87	113	127
UI8	93	94	99	85	87	92	104	60

We used the same four hybrids plus two additional low-sucrose hybrids to represent a broad range in sucrose content. Evaluations were made on 30 plants of each hybrid at 3, 4, and 5 weeks post emergence. Data taken were: 1) specific gravity, 2) root percent dry weight, 3) percent soluble solids, 4) osmotic pressure, 5) percent sucrose, 6) percent non-sucrose soluble solids, and 7) percent non-soluble dry matter. Percent sucrose was determined by combining all roots of one treatment. Therefore, there was no replication for percent sucrose and thus no statistical reference. Percent non-sucrose soluble solids and percent non-soluble dry matter were made by substraction. Data are given in Table 9.

There was a within-line correlation between fresh root weight and specific gravity and between fresh root weight and percent dry weight in the youngest plants but not in older plants. As the plant matures and the true root cells predominate, the relationship disappears.

Specific gravity was highly correlated with percent dry weight at all ages for both within and between lines ($r = 0.90$ to 0.95). Likewise, soluble solids were highly correlated with osmotic pressure at all ages ($r = 0.70$ to 0.90). A low correlation between these two parameters would indicate that the osmolites in the different genotypes were of different size and

Table 9. Harvest percent sucruse and specific gravity, percent dry matter, percent soluble solids, osmotic pressure, percent non-sucrose soluble solids, percent non-soluble dry matter, and seedling percent sucrose for five beet hybrids at 3, 4, and 5 weeks post emergence.

	Specific gravity	Dry matter %	Soluble solids %	Osmotic pressure mOs/kg	Non-sucrose sol. solids %	Non-soluble dry matter %	Seedling sucrose %	Harvest sucrose %
5-week-old								
UI8	1.074	23.1	18.4	649	5.7	4.8	12.7	16
GWD2	1.071	21.2	16.6	589	5.0	4.6	11.6	16
Monorosa	1.060	19.6	-	-	-	-	-	13
Lamono I	1.065	20.2	17.0	631	5.8	3.2	11.2	12
USH10	1.071	22.2	18.5	675	7.0	3.7	11.5	14
ACH14	1.079	23.8	18.6	683	6.0	5.2	12.6	17
LSD 0.05	0.004	1.0	1.3	50				0.7
4-week-old								
UI8	1.058	18.9	16.6	676	9.8	2.3	6.8	16
GWD2	1.060	19.6	14.5	614	7.3	5.1	7.2	16
Monorosa	1.050	17.4	14.3	655	10.2	3.1	4.1	13
Lamono I	1.047	16.2	13.5	629	7.7	2.7	5.8	12
USH10	1.060	18.3	15.3	661	9.3	3.0	6.1	14
ACH14	1.070	20.7	16.1	698	10.4	4.6	5.6	17
LSD 0.05	0.006	1.4	1.5	48				0.7
3-week-old								
UI8	1.052	15.6	9.3	622	5.1	6.3	4.2	16
GWD2	1.052	14.9	8.6	649	4.1	6.3	4.4	16
Monorosa	1.044	12.7	8.4	650	4.5	4.3	3.9	13
Lamono I	1.041	11.7	7.1	639	4.1	4.6	3.0	12
USH10	1.048	14.3	8.6	670	4.3	5.6	4.3	14
ACH14	1.048	14.8	9.8	749	5.9	5.0	3.9	17
LSD 0.05	0.003	1.1	0.9	31				0.7

charge. What this correlation suggests is that the osmolites in the different genotypes are very similar but of different concentrations.

Specific gravity and percent dry matter gave good correlations with harvest percent sucrose, whereas the relationship for soluble solids and osmotic pressure were poorer. One reason for the positive correlations was due to the hybrid ACH14, which had a high percent sucrose and was high in the above four parameters at each age. However, there were some notable discrepancies. GWD2 has a significantly higher sucrose content than USH10; however, the soluble solids and osmotic pressures were always higher for USH10. The USH10 specific gravity and percent dry matters were generally equal to or higher than that for GWD2. The hybrid Monorosa was also higher in soluble solids and osmotic pressure than GWD2 and it has a considerably lower potential sucrose content. An explanation of these discrepancies can be obtained from the calculation of non-sucrose soluble solids. The hybrid GWD2 is low in non-sucrose soluble solids, whereas the hybrids Monorosa and USH10 are high in non-sucrose soluble solids.

The osmotic pressure is not different between these hybrids, even though they have big differences in potential sucrose concentration. The difference is made up of higher concentrations of other osmolites. The different genotypes adjust for different concentrations of sucrose by increasing or decreasing the concentration of other osmolites. This has the tendency to confound the correlations between percent dry matter and percent sucrose and specific gravity and percent sucrose. The original assumptions that beet seedlings do not differ in concentration of sucrose or non-sucrose soluble solids is only correct for a limited number of genotypes and is not generally valid.

The best relationship was between non-soluble dry matter content and sucrose percent in the older plants. By this time, the effect of cortex cells is minimal; i.e., most of the root cells are true root cells. By eliminating the soluble dry matter, the remaining dry matter is largely cell wall and percent cell wall should give a relative measure of cell size.

IV. GROWTH ANALYSIS

D. L. Doney and J. C. Theurer

A. GENOTYPE VS. PLANT DENSITY

After several spacing studies with sugarbeets, it has generally been concluded that rows 50 to 55 cm (20 to 22 inches) apart and plants spaced 20 to 30 cm (8 to 12 inches) within the row are optimum for highest sugar production. Consequently, varieties being tested for potential commercial production are selected and evaluated in the field at these standard plant densities. Yields of several crops, however, have been increased in the past decade by altering what had previously been supposed as the optimum for field production. Past research at the Logan station has shown both positive and negative results from altering plant density.

In a 1979 study (see 1979 Sugarbeet Research Report, P. 19), the performance of three inbreds and a commercial hybrid were compared in rows 30 cm (12 inches) versus 60 cm (24 inches) apart. It was concluded that sugar yield could be increased at narrower row widths than the standard 50 cm (22 inches). Inbreds did not effectively utilize the 60-cm spacing, and at the narrower row width, their sugar yield approached that of the hybrid. Data of a 1980 field test of four hybrids suggested that a row spacing of 42 cm (16.5 inches) was more optimum than the standard 50 cm (22 inches) width between rows. Interactions were noted for genotypes and plant density. This study was repeated with five hybrids in 1981 field tests.

Materials and Methods

Three commercial varieties and two experimental hybrids were used in the experiment. The commercials were selected for differences in top growth as well as for their high yielding ability in our area. GWD2 has a large upright canopy. ACH130 has a fairly large top, but less erect than GWD2. Beta 9421 has a relatively small top. The two experimental hybrids consisted of one that was composed from high sucrose content lines, and the other from high root yield lines. The test was planted at Farmington, Utah, in a split-plot design with six replications. The individual plots were 2.24 m (88 inches) wide and 9 m (30 feet) long.

Distances between rows were 33.5, 42, and 56 cm (13.2, 16.5, and 22 inches) for the respective plant densities of: 87, 900, 73, 400, and 58,500 plants per hectare (35,600, 29,700, and 23,700 plants/acre). Plants were thinned to 20 to 30 cm (8 to 12 inches) between beets in all plantings. Excellent stands were attained at the time of thinning in all plots. At harvest, some of the plots showed some loss in stand due to root rots. Beta 9421, and the experimental hybrids showed more rotting than the other two commercial varieties. All beets were harvested by hand during the first week of October. Tops were removed at the lowest leaf scar and roots and tops were weighed immediately. A 10-beet sample from each plot row was taken to the laboratory for sucrose percentage, and impurity factors by standard methods. Data from the entire plot was combined for statistical analysis.

Results

Significant differences were noted for varieties for all measured characteristics (Table 1). Significance was observed for density only for sucrose percentage, Na, and K content. None of the interactions of variety X density showed meaningful differences. GWD2 had a higher sugar yield than ACH130 or LHY2 (Table 2). The root weight of the commercial varieties exceeded that of the two Logan experimental hybrids (Table 3). As expected, LHS3 showed significantly the highest sucrose percentage (Table 4). There was no difference in the sucrose content of the four other varieties. There was a general tendency for mean sucrose to increase with plant density.

The 6-row plots averaged significantly higher sucrose percentage than the 4-row plots. GWD2 was higher in Amino N than the other hybrids (Table 5), but significantly lower in sodium (Table 6). ACH130 was also high in sodium in this experiment. The 5-row plots showed significantly less Na than 4-row plot densities. The LHY2 hybrid had significantly less potassium than the other varieties (Table 7). There was a trend for quality improvement in potassium content with increasing plant density. The 6-row plots averaged significantly less potassium content than the less dense 4-row plots. The two Logan experimental hybrids had significantly lower impurity index values than the three commercial hybrids (Table 8).

Table 1. Significance of F values from ANOV for hybrid density field trial, Farmington, Utah, 1981.

Source	dif.	Total sugar yield dt/ha	Root weight t/ha	Sucrose %	Amino N ppm	Na ppm	K ppm	Impurity Index
Density	2	ns	ns	*	ns	*	*	ns
Variety	4	*	**	**	**	**	**	**
Density X Variety	8	ns	ns	ns	ns	ns	ns	ns

* = Significant at 0.05 level.
**= Significant at 0.01 level.

Table 2. Total sugar yield, dt/ha, for hybrids at 3 plant densities, Farmington, Utah, 1981.

Variety	4-row 58,500[1/]	5-row 73,400	6-row 87,900	Mean
GWD2	103.9	106.8	101.6	104.1
ACH130	98.9	96.9	98.9	98.2
Beta 9421	103.9	101.0	103.8	102.9
LHS3	100.0	101.3	100.5	100.6
LHY2	97.8	97.0	100.8	98.5
Mean	100.9	100.6	101.1	100.9

LSD 0.05 Variety Mean 4.46
Density Mean 5.30

[1/] Plants per hectare

Table 3. Root weight, t/ha, for hybrids at 3 plant densities, Farmington, Utah, 1981.

Variety	4-row 58,500	5-row 73,400	6-row 87,900	Mean
GWD2	64.05	63.90	60.33	62.8
ACH130	63.05	59.86	60.62	61.2
Beta 9421	65.85	64.73	62.51	64.4
LHS3	56.63	56.01	55.67	56.1
LHY2	62.73	61.12	63.16	62.6
Mean	62.4	61.3	60.4	61.4

LSD 0.05 Variety Mean 2.51
Density Mean 2.11

Table 4. Sugar percentage for hybrids at 3 plant densities, Farmington, Utah, 1981.

Variety	4-row 58,500	5-row 73,400	6-row 87,900	Mean
GWD2	16.3	16.7	16.8	16.6
ACH130	15.7	16.2	16.3	16.1
Beta 9421	15.8	15.6	16.7	16.0
LHS3	17.7	18.1	18.1	18.0
LHY2	15.6	15.7	16.0	15.7
Mean	16.2	16.5	16.8	16.5

LSD 0.05 Variety Mean 0.35
Density Mean 0.42

Table 5. Amino nitrogen ppm for hybrids at 3 plant densities, Farmington, Utah, 1981

Variety	4-row 58,500	5-row 73,400	6-row 87,900	Mean
GWD2	311	360	283	318
ACH130	246	242	241	243
Beta 9421	272	279	235	262
LHS3	281	292	281	285
LHY2	245	243	218	235
Mean	271	283	252	269

LSD 0.05 Variety Mean 34
Density Mean 56

Table 6. Sodium ppm for hybrids at 3 plant densities, Farmington, Utah, 1981.

Variety	4-row 58,500	5-row 73,400	6-row 87,900	Mean
GWD2	96	90	96	94
ACH130	208	155	176	180
Beta 9421	133	125	121	126
LHS3	151	126	148	142
LHY2	147	136	135	139
Mean	147	126	135	137

LSD 0.05 Variety Mean 11
Density Mean 16

Table 7. Potassium ppm for hybrids at 3 plant densities, Farmington, Utah 1981.

Variety	4-row 58,500	5-row 73,400	6-row 87,900	Mean
GWD2	1797	1783	1761	1780
ACH130	1910	1866	1801	1859
Beta 9421	2022	1957	1864	1948
LHS3	1894	1807	1764	1822
LHY2	1524	1480	1407	1470
Mean	1830	1779	1720	1776

LSD 0.05 Variety Mean 65
Density Mean 85

Table 8. Impurity index for hybrids at 3 plant densities, Farmington, Utah, 1981

Variety	4-row 58,500	5-row 73,400	6-row 87,900	Mean
GWD2	487	500	451	479
ACH130	508	470	463	480
Beta 9421	524	521	449	498
LHS3	459	435	429	441
LHY2	436	423	387	415
Mean	483	470	436	463

LSD 0.05 Variety Mean 28
Density Mean 43

Discussion

The results of the test failed to confirm the 1980 conclusion that the 5-row, 42-cm (16.5 inches) spacing was superior to either lower or higher plant densities. In particular, we did not expect the varieties which show so many significant different characteristics in growth, root weight, and sucrose content to behave similarly at all three plant densities. Year to year differences may be explainable in terms of harvest method. In 1980, and previous years, the border rows of a plot were not harvested, whereas in 1981 we harvested the entire plot. The two external rows on the 5-row and 6-row units did show greater vigor and they had greater root weight. It may be that they contributed enough to the plot yield to offset the competitive effects of the internal rows. This year's test did show the tendency noted in previous years for sucrose percentage to increase, and impurity factors to decrease with increasing plant density.

Inasmuch as we harvested the rows of each plot separately, we can analyze the data to compare whole plot harvest versus plot yield, eliminating border rows. However, time doesn't permit this comparison to be made so as to be included in this report.

Although varieties behaved similarly, we feel it may still be possible to increase sugar yield if direct selection were made for high performance in plots of greater density than the conventional 56-cm (22 inches) row spacing.

B. ROOT/TOP PARTITIONING AMONG INBREDS AND THEIR DIALLEL CROSS HYBRIDS

One would suppose that high sugar production is dependent upon the partitioning of photosynthate to the top and to the root, and subsequent partitioning of root photosynthate between sucrose storage and root growth. Studies during previous years have shown differences in partitioning of genotypes between tops and roots, and that the root is primarily responsible for such partitioning. In 1981, we initiated a field study to determine how diverse genotypes partition photosynthate during the growing season, how the partitioning relates to yield, and the response of inbred partitioning related to its hybrids. Four genotypes were selected for the study. These are listed below:

Code	Description
HRP	Inbred selected for high partitioning to the root.
HS	Inbred high in sucrose content and high in general combining ability for sucrose.
HY1	Inbred high in yield and high in general combining ability for yield.
HY2	Inbred with low yield but good general combining ability for high yield.

Seed of a diallel cross between all four inbreds was made in 1980. Insufficient seed was obtained of the cross HY1 X HS; therefore, it was not included in the 1981 field test. The inbreds and partial diallel were planted in four replications of a random block design. Individual plots consisted of two rows, 56 cm (22 inches) apart, and 6 m (18 feet) long. At harvest, 10 competitive beets from the center of each row were dug by hand. Tops were removed by trimming all green from the crown of each root. Tops and roots were immediately weighed following their separation. Two representative tops were selected, weighed, and dried in an oven at 100 C to determine the dry matter percentage of the tops. The roots were washed and sampled with a spreckles saw to obtain brei for laboratory analysis. Sucrose percentage was determined by the cold digestion method. A sample of pulp was collected in an aluminum weighing dish and dried in an oven at 100 C to obtain a dry matter percentage of the root for each variety. Four harvests were made during the year on the following dates: July 1, August 4, September 9, October 14 and 19. Due to rain, the fourth harvest had two dates. Two replicates were harvested on each date. Root/top ratios were determined on both a fresh weight and dry weight basis.

Results

The fresh weight root/top ratios indicating the partitioning to the root and top for inbreds and hybrids is given in Table 1.

Table 1. Root/top fresh weight ratios for four diverse inbreds and their hybrids during the growing season, Logan, Utah, 1981.

Entry	H1	H2	H3	H4
HRP	.34	.90	1.75	2.57
HS	.21	.55	.70	1.17
HY1	.22	.56	.67	1.35
HY2	.26	.78	1.53	3.87
HY1 X HRP	.28	.63	.94	1.63
HY2 X HRP	.25	.60	1.16	1.80
HS X HRP	.27	.57	.88	1.24
HY2 X HS	.23	.56	.88	1.26
HY1 X HY2	.20	.51	.86	1.33
F	10.50**	8.81**	44.36**	91.44**
Mean	0.25	0.63	1.04	1.80
LSD 0.05	0.04	0.13	0.16	.27
CV	10.27	13.90	10.71	10.33

There was a steady increase in the R/T ratio with each succeeding harvest. The HRP inbred, as expected, had significantly the highest R/T ratio at the first harvest. HY2 was the second highest inbred for R/T ratio at Harvest 1, and rapidly increased with each harvest until at Harvest 4 this inbred was significantly greater in R/T ratio than all other entries. It was also interesting to note that the HS inbred and the HY1 inbred had parallel ratios during all harvests even though one genotype is a high-sucrose type and the other has good combining ability for root yield. The diallel cross hybrids varied considerably less than inbreds in R/T ratio, but did show significantly different ratios at each harvest. Hybrids with HRP parentage had the highest R/T ratios, demonstrating that partitioning is a heritable factor. As would be expected from the inbred ratios, HY2 X HRP had significantly the highest R/T ratio of the hybrids.

Root/top ratios on a dry weight basis are summarized in Table 2. While the ratios are slightly higher on a dry matter than a fresh weight basis (compare Tables 1 and 2), the results for the entries are very similar. HRP and HY2 inbreds and the hybrid of these two parents were the ones having the highest root weight relative to top weight.

The total sugar yield for all entries at each harvest is summarized in Table 3. At Harvest 1, HY1 significantly outyielded the other inbreds and was equal to some of the hybrids. HY1 significantly outyielded HRP and HY2 for all other harvests, even though the latter two inbreds had significantly higher partitioning ratios. This may indicate that HRP and HY2 lacked sufficient early development of their canopy to intercept as much sunlight as HY1, thus they were slower to develop because of poor photosynthesis capacity. They may also be slower in development due to a physiological problem of sucrose transport.

Table 2. Root/top dry matter ratios for four diverse inbreds and their hybrids during the growing season, Logan, Utah, 1981.

Entry	H1	H2	H3	H4
HRP	.54	1.16	2.67	2.95
HS	.20	.65	1.03	1.52
HY1	.26	.59	1.09	1.57
HY2	.41	.89	2.16	4.69
HY1 X HRP	.36	.83	1.69	2.00
HY2 X HRP	.32	.89	1.70	2.02
HS X HRP	.46	.76	1.45	1.53
HY2 X HS	.30	.71	1.58	1.70
HY1 X HY2	.26	.76	1.67	1.58
F	3.11*	8.66**	10.36**	36.71**
Mean	0.34	0.80	1.69	2.17
LSD 0.05	0.181	0.17	0.46	0.50
CV	36.08	14.32	18.83	15.94

Table 3. Total sugar yield dt/ha for four diverse inbreds and their hybrids during the growing season, Logan, Utah, 1981.

Entry	H_1	H_2	H_3	H_4
HRP	.48	14.79	47.61	61.43
HS	.89	21.95	59.25	79.00
HY1	1.14	20.61	56.73	87.59
HY2	.60	17.27	40.05	63.91
HY1 X HRP	1.22	24.80	70.76	84.04
HY2 X HRP	.96	21.23	68.89	94.93
HS X HRP	1.42	24.25	70.53	77.44
HY2 X HS	1.26	26.32	67.84	101.53
HY1 X HY2	.93	23.15	69.99	118.59
F	6.45**	9.93**	9.47**	12.51**
Mean	0.99	21.60	61.30	85.38
LSD 0.05	0.35	3.40	10.66	14.85
CV	24.47	10.81	11.94	11.94

The R/T partitioning ratio of hybrids for Harvest 1 on a dry matter basis showed an excellent inverse correlation (r = 0.9) with sugar yield at Harvest 4 (Tables 2 and 3). Hybrids showed differences in rank from harvest to harvest. HY1 X HY2 was lowest in yield at H1 and significantly superior to all entries at H4. This could be attributed to the excellent combining ability of these two lines. It relfects the photosynthetic capacity on HY1 early in the season and the tendency of HY2 to increase R/T ratio partitioning later in the season when the full canopy has developed. Also, the limit of photosynthate production may rest with the ability of the genotype to transport

and assimilate this photosynthate. Although the HRP partitioned more assimilate to the root than to the top, compared with other genotypes at every harvest, this partitioning advantage was not demonstrated in the sugar yield of the hybrids. The highest yielding hybrids were with the HY2 parentage.

The fresh root weight for inbreds and hybrids is summarized in Table 4. HY1 had the greatest root weight of inbreds at all harvests. Inbreds HRP and HY2 with the higher partitioning ratios (Tables 1 and 2) were significantly lower in yield than the other two inbreds tested. The root weight of hybrids showed significant harvest differences. HY2 X HRP was significantly the lowest in root weight at H2. HS X HRP had significantly the lowest root weight at H4. HY1 X HY2 was lowest in root yield at H1, but significantly greater than all other hybrids at H4. Hybrids with HY2 showed the best combining ability for root yield.

Table 4. Fresh root weight t/ha for four diverse inbreds and their hybrids during the growing season, Logan, Utah, 1981.

Entry	H1	H2	H3	H4
HRP	0.72	13.69	34.69	39.44
HS	1.37	19.60	37.52	41.37
HY1	1.54	21.68	45.27	58.02
HY2	0.82	14.75	26.94	38.33
HY1 X HRP	1.75	24.91	52.29	54.14
HY2 X HRP	1.48	20.32	49.69	58.63
HS X HRP	1.84	22.11	46.51	47.51
HY2 X HS	1.84	23.88	45.33	57.04
HY1 X HY2	1.44	22.45	52.09	73.75
F	7.35**	13.05**	9.95**	13.61**
Mean	1.42	20.38	43.37	52.03
LSD 0.05	0.45	3.11	7.95	9.09
CV	21.54	10.47	12.58	12.00

Significant differences were noted for sucrose percentage on a fresh weight basis (Table 5). HY1 was consistently the inbred with the lowest sugar percentage. HS and HY2 had significantly the highest sucrose percentage. Sucrose percentage is inherited in an additive manner and HY2 X HS, as expected, was significantly the highest in sucrose content. HY1 X HRP was lowest in sucrose percentage. Even though HRP partitioned a higher portion of its assimilate to the root, it didn't have a marked effect for increased sucrose content in any of the hybrids where it was a parent. With the exception of Harvest 2, partitioning of sucrose in the root on a dry matter basis showed only minor non-significant differences between entries (Table 6).

In summary, the data indicate that partitioning to the root and the top is different for inbreds and hybrids. Partitioning to the root is a more important factor for increasing sugar production than partitioning within the root for sucrose versus root growth. Lines that show a marked increase in the partitioning of assimilate to the root late in the growing season, coupled with lines that have early photosynthetic capacity, may be the hybrid combi-

nation that is optimum for sugar production. We realize caution must be exercised in drawing conclusions on a single year's data. Harvest 4 was made over a week's period of time and environmental conditions at harvest could have exerted a major influence on the final R/T partitioning and sugar yield results. This test will be repeated in the 1982 field trials to gain a better understanding of partitioning.

Table 5. Sucrose percentage for four diverse inbreds and their hybrids during the growing season, Logan, Utah, 1981.

Entry	H1	H2	H3	H4
HRP	6.9	10.8	13.8	15.9
HS	6.4	11.2	15.8	19.1
HY1	7.4	9.5	12.5	15.1
HY2	7.4	11.7	14.9	16.9
HY1 X HRP	7.0	10.0	13.5	15.5
HY2 X HRP	6.4	10.5	13.9	16.2
HS X HRP	7.6	11.0	15.2	16.4
HY2 X HS	7.0	11.0	15.0	17.8
HY1 X HY2	6.5	10.4	13.5	16.1
F	2.73**	12.67**	22.89**	11.92**
Mean	6.9	10.7	14.2	16.5
LSD 0.05	0.8	0.6	0.6	1.1
CV	7.79	3.55	3.07	4.36

Table 6. Sucrose percentage of dry matter for four diverse inbreds and their hybrids during the growing season, Logan, Utah, 1981.

Entry	H1	H2	H3	H4
HRP	47.53	60.21	68.58	70.60
HS	45.33	58.05	65.73	74.10
HY1	53.05	56.86	65.45	69.73
HY2	47.91	60.44	68.43	72.88
HY1 X HRP	46.70	58.37	63.08	73.60
HY2 X HRP	45.57	59.73	70.18	75.70
HS X HRP	53.05	60.95	72.78	69.50
HY2 X HS	48.19	59.33	64.35	73.90
HYL X HY2	43.62	59.05	66.18	75.43
F	2.29ns	6.04**	2.16ns	0.65ns
Mean	47.88	59.22	67.19	72.83
LSD 0.05	6.27	1.54	6.05	8.45
CV	8.99	1.78	6.18	7.97

V. INSECT STUDIES

SELECTION FOR RESISTANCE TO THE SUGARBEET ROOT MAGGOT

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The root maggot resistance program was continued to 1981 in cooperation with entomologists stationed at the Snake River Conservation Research Laboratory at Kimberly, Idaho. Seed from selections and crosses made in the greenhouse at Logan during the winter of 1980-81 were sent to Dr. Blickenstaff and were planted in early May at Kimberly. Seeds were hand planted one foot apart in 10-foot rows, spaced 22 inches apart, and thinned to one plant per "hill" after emergence for all selection tests. Local fly populations were supplemented by flies trapped north of Paul, Idaho.

In mid-July, plants were hand dug and rated individually on a scale of 0 to 9 (0 = no damage, to 9 = dead or severely damaged). Plant stand and percent of plants infected with curly top was also noted.

Section I

This section included high- and low-damage selections made in 1980 from the heterogeneous 35F3 population, the original 35F3 parent, and L19, an inbred check. A randomized design of 20 replicates was used in the test. Plot size varied due to differences in the amount of seed available. Entries 2, 3, and 4 were one row wide and Entry 1 was two rows wide. This was the third cycle evaluation of high- and low-damage selections from this population. Results are summarized in Table 1.

Table 1. Performance of progeny of 1980 selections from 35F3 populations, 3rd Selection Cycle, Kimberly, Idaho, 1981.

Entry		Description	$\bar{x}$ plant stand per row	% plants with curly top	Total no. plants	$\bar{x}$ SBRM damage rating	% of parent
1.	40J19	Low-damage selection	6.43 a	5.9 a[1/]	247	1.65 a	91
2.	40J38	High-damage selection	7.70 b	11.9 a	153	1.94 b	77
3.	35G3	Parent	8.75 c	8.4 a	175	2.14 b	
4.	L19	Check	6.35 a	59.3 b	127	1.93 b	
F Value				74.51**		6.97**	

[1/] Means with different letters are significantly different at .05 level.

The low-damage selection was significantly less than that of the parent and showed 77 percent as much root maggot damage. In the first selection cycle, maggot damage was reduced 16 percent in this population. In 1980, the second selection cycle, no progress was made as the reduction in damage was only 10 percent. This year's data suggest we may still be able to make progress by further selection in this population.

The high-damage selection didn't differ from the parent. This may be due to the fact that the roots having the highest damage are dead or do not contribute to seed increase, thus diluting the selection in this direction. The low-damage selection also had significantly better stand than the high damage or parent, further indicating the value of selection for resistance.

Section II

This section included high- and low-damage selections made in 1980 out of the 25A2 population. The original parent and the inbred check L19 were also included for comparisons. Individual plots for Entries 2, 3, and 4 were one row wide, and Entry 1 was three rows wide in a randomized design of 20 replications. The data are summarized in Table 2.

Table 2. Performance of progeny of 1980 selections from the 25A2 population, the 6th cycle of selection, Kimberly, Idaho, 1981.

Entry		Description	$\bar{x}$ plant stand per row	% plants with curly top	Total no. plants	$\bar{x}$ SBRM damage rating
1.	40J20	Low-damage selection	9.5 b	3.6 a	381	0.90 a
2.	40J39	High-damage selection	7.1 a	0.7 a	141	1.11 ab
3.	Parent	25A2	7.2 a	3.3 a	143	1.40 b
4.	L19	Check	6.4 a	52.0 b	127	0.97 a
F Value			15.51**	166.72**		4.25**

The parent population and selections from it showed good curly top resistance compared to the highly susceptible L19 check. Significant differences were noted for both stand and SBRM maggot rating for the low-damage selection. The high-damage selection did not differ from the parent for either characteristic. Continued selection progress was again noted in this population for the sixth cycle of selection, when the low-damage selection is compared with that of the parent (Table 3). Continued selection will be made in 1982 in this material in an effort to further increase resistance to the root maggot.

Table 3. Root maggot damage rating in % of the parent population 25A2 for six cycles of selection.

	1976	1977	1978	1979	1980	1981
High-damage selection	116	103	121	115	133	79
Low-damage selection	96	86	89	81	76	64

Section III

Entries for Section III were the first segregating generation (F_2) from crosses made in 1979 between low-damage selections of The Amalgamated Sugar Company and USDA low-damage selections. Plots were single rows, completely randomized with 3 to 9 replications for each entry based upon the quantity of seed available. The data are summarized in Table 4. Most of the crosses showed no curly top damage. There were no differences in the crosses in maggot damage reading, but all scores except for seven entries were rated lower than a 2. Highly significant differences were noted in plant stand. Progress for combining potential resistant genes from the TASCO and USDA sources, if they are different, can only be measured by continued evaluation and selection in the progenies. Further evaluation will be made in 1982.

Section IV

Seventeen self and sib progenies of root maggot resistant lines were reevaluated in 1981. Plots were single rows, completely randomized, and 2 to 20 replications, depending upon the quantity of seed available for planting. The data are given in Table 5. Significant differences were noted in curly top percentage. All entries were significantly more resistant than L19. However, three of the inbreds, 40J8-2, 40J9-3, and 40J11-2, had over 20 percent infected plants. Significant differences were also noted for stand and root maggot damage reading. Entries 1, 4, 5, and 10 had such poor stands that the data for them is questionable. The most maggot resistant lines, 40J14, 40J9-1, and 40I44-2, had less than 67 percent of the damage observed for the L19 check.

Section V

Three crosses between resistant and susceptible selections were evaluated in 1981 to determine the inheritance or breeding behavior for maggot resistance. The F_1, F_2, and BC_1 generations, along with the parents, were grown in single-plot rows completely randomized and replicated 2 to 9 times, based on the quantity of available seed. The resistant parent scored higher than expected based on its readings in previous years (Table 6). This adds confusion to the task of determining inheritance. However, data indicate that maggot resistance may be additive or partially dominant. Individual F_2 plants were saved and the F_3 progenies will be grown in an effort to substantiate inheritance patterns.

Table 4. Performance of F_2 progenies between USDA and The Amalgamated Sugar Company low-damage selections, Kimberly, Idaho, 1981.

	Entry	% with curly top	$\bar{x}$ stand per row	Total no. plants	$\bar{x}$ SBRM damage rating
1	RM X 1	4.3	7.0 cde	28	1.5
2	RM X 2	2.0	8.3 def	50	1.7
3	RM X 3	0	4.0 ab	16	1.2
4	RM X 4	5.3	8.0 def	32	2.1
5	RM X 5	0	2.8 a	14	1.6
6	RM X 6	0	8.7 ef	26	1.7
7	RM X 7	0	3.9 ab	31	2.0
8	RM X 8	0	7.0 cde	49	2.0
9	RM X 9	0	2.3 a	7	2.1
10	RM X 10	0	3.2 a	19	1.8
11	RM X 11	0	7.4 cdef	59	2.1
12	RM X 12	4.4	5.6 bc	39	2.1
13	RM X 13	11.6	6.2 cd	56	1.5
14	RM X 14	0	8.2 def	49	1.9
15	RM X 15	4.2	6.2 cd	37	1.6
16	RM X 16	8.3	5.8 bc	23	2.2
17	RM X 17	0	5.7 bc	17	1.6
18	RM X 18	2.2	9.0 ef	45	1.9
19	RM X 19	2.8	9.0 ef	45	1.6
20	RM X 20	5.2	9.0 ef	45	1.4
21	RM X 21	0	8.3 def	58	1.4
22	RM X 22	0	9.2 f	55	1.7
23	RM X 23	0	7.5 cdef	30	1.4
24	RM X 24	0	6.3 cd	38	1.8
25	RM X 25	0	9.1 ef	73	1.9
26	1166	7.5	5.5 bc	33	1.7
F Value		1.05 ns	9.73**		1.5 ns

Table 5. Performance of inbreds and sib progenies of low-damage selections, Kimberly, Idaho, 1981.

	Entry	% with curly top	$\bar{x}$ stand per row	Total no. plants	$\bar{x}$ SBRM damage rating	% perfect stand	No. roots saved
1	40J3	0 a	6.0 b	12	1.8 bcdef	60	3
2	40J7-2	4.3 a	8.3 c	66	1.6 abcde	83	12
3	40J7-4	0 a	8.8 c	44	2.4 f	88	2
4	40J7-7	0 a	1.5 a	3	1.5 abcd	15	1
5	40J8-2	33.0 b	6.0 b	6	2.2 ef	60	1
6	40J9-1	4.7 a	6.0 b	36	1.3 ab	60	5
7	40J9-3	35.0 b	5.0 b	30	1.5 abcd	50	1
8	40J9-4	1.8 a	5.8 b	46	1.6 abcde	58	7
9	40J11-2	20.8 ab	5.3 b	21	2.0 cdef	53	4
10	40J14	0 a	1.0 a	1	1.0 a	10	1
11	40I15+a	5.8 a	4.2 b	84	1.7 bcde	42	11
12	40I36-2	5.0 a	9.3 c	37	1.8 bcdef	93	5
13	40I43-2	1.3 a	9.0 c	81	1.9 bcdef	90	14
14	40I44-2	0 a	8.3 c	25	1.4 abc	83	8
15	40I59	1.1 a	8.0 c	120	1.8 bcdef	80	18
16	40I63	6.2 a	8.2 c	49	1.7 bcde	82	14
17	40I64	7.7 a	8.2 c	82	1.5 abcd	82	17
18	L19	75.0 c	4.0 b	16	2.1 def	40	
F Value		5.82**	9.24**		1.79*		

Table 6. Mean root maggot readings for parents, F_1, F_2, and BC_1 progenies of three resistant X susceptible crosses, Kimberly, Idaho, 1981.

	No. plants scored	$\bar{x}$ maggot damage reading
Cross No 1		
Parent 1 (RMR 1.8)	54	2.3
Parent 2 (RMS 2.7)	20	3.0
F_1 Progeny	13	1.2
F_2 Progeny	42	2.6
	72	2.2
	40	1.8
BC_1 (RMR1.8)	18	2.0
	35	2.1
Cross No 2		
Parent 1 (RMR 1.8)	54	2.3
Parent 3 (RMS 2.7)	40	2.9
F_1 Progeny	9	1.1
F_2 Progeny	19	2.9
	32	2.4
	28	2.3
BC_1 (RMS 2.7)	26	2.3
	26	1.8
Cross No 3		
Parent 4 (RMR 1.8)	55	2.0
Parent 3 (RMS 2.7)	40	2.9
F_1 Projeny	10	2.5

Combining Ability of a Root Maggot Resistant Selection

An inbred selected for good resistance to root maggot damage was crossed to three inbred testers: C16CMS, L53CMS, and L29CMS, and tested in the field at Farmington, Utah, in 1981. The test also included the parent maggot resistant line and two commercial checks. Each plot consisted of two rows, 30 feet (9 m) long in six replicates of a random block design. The GWD2 check was significantly better in root yield, sucrose percentage, and sugar yield than the single-cross root maggot resistant hybrids (Table 7). However, there was no significant difference for any of these measurements and AH14, which is the predominant variety in the Idaho area where root maggot is a problem. The inbred parent had the best quality in the test. Hybrids showed equal or lower impurity index values than the commercial checks. We can conclude that this line has fairly good combining ability. It had a curly top rating of 4.0 in the 1981 curly top nursery.

Table 7. Root weight, sucrose percentage, sugar yield and impurity factors for root maggot resistant inbred hybrids, Farmington, Utah, 1981.

	Total Sucrose dt/ha	Root Weight t/ha	Sucrose %	Amino N ppm	Na ppm	K ppm	Impurity Index
GWD2	124.2	75.1	16.5	359	211	1970	608
AH14	112.8	73.8	15.3	384	245	1829	619
C16 X 40G1	108.6	70.1	14.9	350	200	2162	648
L53 X 40G1	105.8	70.6	15.0	299	182	1714	520
L29 X 40G1	102.1	66.8	15.3	323	165	1902	559
40G1	86.0	56.3	15.3	335	93	1712	481
F Ratio	10.59**	7.41**	3.8*	1.56ns	13.63**	15.76**	8.29**
CV	8.9	9.1	7.9	16.9	18.8	5.6	10.0
LSD 0.05	11.3	7.5	.7	69	41	126	68
Mean	106.7	69.3	74.4	342	183	1882	570

VI. DISEASE STUDIES

EVALUATING SUGARBEET SEEDLINGS FOR RESISTANCE TO POWDERY MILDEW

D. L. Mumford and J. C. Theurer

Since its initial epiphytotic occurrence in 1974 (1, 3), powdery mildew (Erysiphe polygoni DC) has consistently ranked as one of the most serious diseases of sugarbeet (Beta vulgaris L.). The disease is controlled primarily by applying sulfur (2, 4). In some situations, three or more applications are required. The sulfur has been very effective in reducing losses; however, the development of resistant cultivars is an economically and environmentally desirable long-range objective.

With that objective in mind, we have identified sources of resistance and determined that seedlings can be used to evaluate resistance. This paper reports results of how well each of three methods of evaluating sugarbeet seedlings for reaction to powdery mildew correlated with evaluations made in the field under natural infection.

Materials and Methods

Twenty sugarbeet cultivars or breeding lines were selected as representing a wide range of reactions to powdery mildew based on evaluations in the field and greenhouse. The reaction to powdery mildew for each of these lines was determined by evaluating it in the field under natural infection for three years, and by subjecting it to three different seedling methods using artificial inoculation.

Field Evaluation

Four 20-root rows of each line were planted in a randomized block design. Planting was done during early May near Farmington, Utah, in 1978, 1979, and 1980. Natural infection occurred each year beginning in August, and evaluations were made in mid-September.

Powdery mildew development on the foliage was evaluated by visually assigning a rating of 1 to 5 to each row based on the extent of mycelial growth and sporulation. A rating of 1 indicated very sparse mycelial growth and no evidence of sporulation, whereas a rating of 5 indicated dense mycelial growth and abundant sporulation.

Cotyledon Method

Plants were grown in the greenhouse for three weeks until the cotyledons were fully expanded and the first true leaf was beginning to emerge. A section 1 cm long was cut from a cotyledon of each of 12 plants per line tested. Cotyledon sections were placed underside up in a randomized block pattern on a sheet of moist filter paper. The sheet of filter paper was positioned at the bottom of an inoculation chamber consisting of a plywood column 1.2 m high and 0.5 m

square.

Inoculation was accomplished by shaking infected leaves at the top of the chamber so conidia settled uniformly on the surface of the cotyledon sections. Conidia were blown off of infected leaves two days before they were used for inoculation. Therefore, most conidia used as inoculum were less than 48 hours old. Inoculum dosage was measured by placing agar strips with the cotyledon sections and counting conidia on the agar surface. Dosage was routinely adjusted to 8 to 10 conidia per mm^2 of surface.

Each inoculated section was floated on 1 ml of water containing 40 µg/ml benzimidazole in plastic 96-cup disposable trays. The trays were enclosed in zip-close polyethylene bags to prevent evaporation and incubated for six days in a growth chamber. The growth chamber was operated with 10-hour days at 22 C, and 14-hour nights at 18 C. The trays of cotyledon sections were placed 20 cm below 15-w fluorescent lights (3063 lux).

Fungus development on cotyledon surfaces was evaluated by examining each section with X 30 magnification. A rating of 1 to 5 based on extent of mycelial growth and abundance of sporulation as in field evaluations was assigned each section.

Leaf-Disk Method

Seedlings were grown in the greenhouse for 5 weeks or until their first true leaves were fully expanded. A disk 1 cm in diameter was cut from near the base of the blade of the first or second true leaf of each plant to be tested. The disks were cut with a No. 5 cork borer. Disks from 12 plants were used to evaluate each sugarbeet line. The disks were placed underside up on moist filter paper in a randomized block pattern and inoculated using the same procedure described above for cotyledon sections. Incubation of inoculated disks and evaluations were also as for cotyledon sections.

Whole-Seedling Method

Seedlings were grown in the greenhouse for five weeks before inoculation. The seedlings were randomly arranged in a walk-in growth chamber with doors that could be closed to reduce air currents. Each entire seedling was inoculated by holding infected plants with abundant sporulation about 60 cm above the seedlings and then shaking them to dislodge the conidia. This procedure was repeated two or three times to insure a uniform distribution of conidia.

The inoculated seedlings remained in the growth chamber for 7 or 8 days until disease symptoms developed. The growth chamber was operated on a 16-hour day (fluorescent light at 4,500 lux) at 25 C, and 8-hour night at 20 C. Reaction to powdery mildew was evaluated by assigning a disease rating of 1 to 5 as described for the other methods.

Results and Discussion

Significant differences occurred in powdery mildew disease ratings assigned

Table 1. Sugarbeet powdery mildew ratings and correlations of field plots with seedling assay methods

Cultivar or breeding line	Assay Method			
	Field[a]	Cotyledon[b]	Leaf disk[b]	Seedling whole plant[b]
L37	1.0[c]	3.1	3.4	1.9
FC504	1.1	2.0	2.5	2.6
EL40	1.2	1.8	1.8	1.7
L53	1.4	2.1	2.4	3.0
8513	1.5	2.0	2.6	2.3
S72-316	2.1	1.8	2.0	1.8
53100-04	2.2	2.3	2.2	4.0
S72-315	2.7	1.8	2.1	2.0
L56	2.8	1.4	2.3	1.4
1345	2.8	2.8	2.5	3.3
L8	3.0	1.5	1.6	2.6
L19	3.2	2.7	2.6	4.4
D2	3.5	3.1	2.9	3.9
NB1	3.6	3.0	2.5	3.0
L10	3.7	2.8	3.0	3.9
AH12	3.8	2.8	2.3	4.0
A5	3.8	2.2	2.7	3.0
HH22	4.0	2.5	2.6	3.8
UI8	4.3	2.0	2.0	3.8
L54	4.9	2.6	3.3	3.9
LSD 0.05	0.6	0.9	0.7	0.7
Correlations w/ field plots		0.30	0.16	0.65**

[a] Field ratings are averages of four replications in each of 3 years.

[b] Ratings are averages of three tests of four replications each.

[c] Ratings based on scale of 1 to 5 with 1 = very sparse mycelium development and no evidence of sporulation, and 5 = dense mycelium development and abundant sporulation.

** Significant correlation of P = 0.01

to 20 sugarbeet cultivars and breeding lines when exposed to natural infection in the field (Table 1). Field ratings were similar for entries over three years. Commercial cultivars D2, AH12, HH22, and UI8 were susceptible. Resistant breeding lines such as L37, FC504, EL40, and L53 have diverse genetic backgrounds and may be excellent sources for developing cultivars resistant to powdery mildew.

The powdery mildew ratings for the three seedling assay methods are listed in Table 1. Ratings differed significantly with the cotyledon and leaf-disk methods. However, these methods do not warrant further consideration because the range of disease reactions was narrow and the correlations with field ratings were low. It was observed during this study that injury influenced powdery mildew development, and this may explain the lack of correlation between cotyledon and leaf-disk ratings and field ratings. The greatest injury effect would occur with leaf-disks, and this method gave the poorest correlation with field evaluations.

The whole-seedling method gave the highest correlation with field results ($r = .65$). If we exclude lines L53 and 53100-04, which had higher seedling than field ratings, and line 56, which had a lower seedling than field rating, the correlation of whole-seedling and field ratings is $r = .79$. All nine of the lines that received field ratings over 3.0 were classified 3.0 or higher in the whole-seedling test. All but three of the 11 lines that received 3.0 or lower field ratings were classified below 3.0 in the whole-seedling test (Table 1). These results indicate that the whole-seedling method of evaluating for powdery mildew resistance could effectively identify susceptible lines but would occasionally fail to identify a resistant line.

It should be noted that a growth chamber was used for inoculation and disease development because this investigation was not compatible with non-disease work being done in the greenhouse. Other testing has shown, however, that seedling evaluation can be done in the greenhouse, particularly if shading is provided during periods of intense sunlight.

This seedling method requires only six weeks to complete and can be done anytime during the year. Resistant selections are not destroyed in the evaluation process but can be recovered for reproduction. This method should facilitate the development of resistant cultivars and the study of how resistance is inherited.

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Evaluation of Sugarbeets for Resistance to Powdery Mildew

Field Plots, Farmington, Utah, 1981

Cultivar or line	Rating[a/]	Cultivar or line	Rating
EL40	1.0	L8	3.0
L37	1.0	L35	3.3
FC504	1.3	1345	3.3
8513	1.5	A5	3.5
L53	2.0	D2	3.5
L34	2.3	L40	3.8
S72-301	2.3	L10	3.8
S72-316	2.3	USH20	3.8
L38	2.5	HH22	4.0
L19	2.8	L50	4.0
L56	3.0	L54	4.3
L57	3.0	AH14	4.8
LSD 0.05 = 0.5			

[a]Rating based on scale of 1 to 5 with 1 = very sparse mycelium and no evidence of sporulation, and 5 = dense mycelium and abundant sporulation.

VII. POTENTIAL ALCOHOL FUEL RESEARCH

J. C. Theurer and D. L. Doney

An intensive effort was initiated in 1980 to evaluate fodder beet and sugarbeet varieties for their potential production of biomass for fuel. Approximately 70 varieties of fodder beet selected for their high root yield and dry matter content were evaluated in replicated field trials at several locations. Based on the results of these trials, the most productive varieties were selected for reevaluation in 1981.

A. NATIONAL COOPERATIVE FUEL BEET TRIALS

A national uniform cooperative fuel beet trial was established in 1980 under the supervision of Dr. Theurer. Fourteen of the most productive fodder beet varieties from Europe were planted at six locations in the United States. A commercial hybrid sugarbeet variety, GWD2, was included in each test as a uniform check. In addition, another commercial hybrid, selected by the cooperating scientist at each location, was included as the local check for that particular location. Results of these field trials were reported in the 1980 Research report, P. B44. Locations and cooperating scientists at each location are given below:

Location	Cooperating Scientist
Logan, Utah	Dr. Devon Doney, Research Geneticist
Aberdeen, Idaho	Dr. John Gallian, University of Idaho Extension Agronomist
Salinas, Calif.	Dr. Robert Lewellen, Research Geneticist
Fort Collins, Colo.	Dr. Garry Smith, Research Geneticist
East Lansing, Mich.	Dr. George Hogaboam, Research Agronomist
Fargo, N. Dak.	Dr. William Bugbee, Research Plant Pathologist

A national trial was conducted again this past summer at the same locations with the same cooperating scientists.

Materials and Methods

Experimental Design: The experiment was planted at each location in six replications of a random block design. Individual plots consisted of four rows, approximately 6 m (20 feet) long and of a standard row width of 56 cm or 71 cm (22 or 28 inches) normally used for sugarbeets at the specific location. At the 4- to 6-leaf stage of development, plots were thinned to leave a single plant every 20 to 30 cm (8 to 12 inches) within the row. Planting dates and harvest dates were as follows:

	Logan	Aberdeen	Ft. Collins	Salinas	E. Lansing	Fargo
Planting Date	April 28	April 15	April 21	March 12	May 12	May 7
Harvest Date	Oct 26	Oct 19	Oct 10	Oct 5	Oct 20	Sept 24

Cultural Practices: Fertilizer and irrigation were the standard practices for growing sugarbeets at each location. Preplant application of herbicides was used at Fort Collins, Salinas, and East Lansing for weed control. At Salinas, plots were sprayed twice with meta-systox for aphid control and three times with wetable sulphur to control powdery mildew. A weekly spray program with malathion was used at Logan as a means of precluding curly top disease. Du-ter was applied in August at Fargo for Cercospora Leaf Spot control. Fort Collins experienced a hail storm on May 6 when seedlings were emerging, but there were no serious effects. Most of the experiments had excellent to good stands.

Varieties: Sixteen varieties were included in the experiment. Seven were European sugarbeet X fodder beet hybrids that showed the greatest sugar yield in national trials in 1980. Four entries were European sugarbeet X fodder beet hybrids that had the highest sugar yield in 1980 intermountain research tests conducted in Utah and Idaho. GWD2 hybrid was again used as the standard check for all locations. Three other check varieties that were different for each location represented the current or potential highest sugar yield varieties for that location. The varieties and their characteristics are given in Table 1.

Personnel at Logan packaged the seed of each variety and sent them to the various locations prior to planting. Each cooperator randomized their own field plan and planted the experiment.

Harvest and Laboratory Procedures: Variety trials at each location were harvested by hand. All beets from 18 feet of the two center rows of each plot were dug, cleaned, and topped by removing all of the green from the crowns and leaving the crowns intact with the root. Roots were immediately weighed and 10+ beets from each plot were utilized to evaluate sucrose percentage. Percent sucrose was determined by the cold digestion method for the Logan, Aberdeen, and Salinas locations, and by the thin juice method at Fort Collins, Fargo, and East Lansing. Na and K content were determined at Logan and Aberdeen locations using standard laboratory techniques. A sample of pulp was weighed, oven-dried at 100 C and reweighed to determine the dry matter percentage of the root for each variety. Brei samples were clarified with aluminum sulfate solution (1 gm anhydrous aluminum chloride/liter of water). A 10-ml of filtrate from each field plot at each location was frozen and shipped by air to Logan for use in determining sugars other than sucrose. Reducing sugars (glucose and fructose) were quantified using dinitrosalicylic acid reagent and evaluated colorimetrically.

Data Summary and Statistical Analysis: Raw data was transcribed on a series of data sheets for each location and sent to Logan for statistical analysis and summarization of the research project.

Results: Yield and quality factor data is summarized in Table 2 for Logan, Table 3 for Aberdeen, Table 4 for Fort Collins, Table 5 for Salinas, Table 6 for East Lansing, and Table 7 for Fargo locations.

Total Sugar Yield: Total sugar yield is the most important factor that was measured since it indicates the basic amount of sugar available for fermentation to alcohol. Significant differences between varieties were observed for total sugar yield at only two of the six locations, Logan (Table 2) and Fort Collins (Table 4). These differences were mainly attributable to the low sugar

production of Monorosa, Hugin, and GWD2 at Logan, and Hugin and Zwaan Poly at Fort Collins. At Logan (Table 2) GWD2 yielded 25 percent less than the highest yielding variety, Lamono II; however, this variety was only 3 percent greater than GWH149 or Hillshog 309. At Aberdeen, Lamono I and Lamono II fodder beets were equal with D2 at 150 dt/ha (Table 2). The variety Monovigor was 14 percent greater than GWD2, but only 2 percent over the high yielding check GWE4 at Fort Collins (Table 4). At Salinas, Monovigor fodder beet exceeded the standard GWD2 check by 3 percent but it was 3 percent less than Holly 7334-05 (Table 5). Comparisons at East Lansing (Table 6) showed Monovert 12 percent greater than GWD2 and 6 percent less than USH23. At Fargo (Table 7), GWD2 and Monova, the highest yielding of the three check varieties, averaged 3 percent less sugar yield than did TC5/45-9.

The fodder beet varieties Lamono II, TC4/45-9, Monovigor, Lamono I, and Monovert were the best yielding fodder beet varieties.

Root Weight: The root weights averaged from 68 t/ha at Fargo (Table 7) to 114 t/ha at Aberdeen (Table 3). In general, the fodder beets had significantly higher root weight than the highest yielding sugarbeet hybrid check at each location. However, there were five varieties at Logan (Table 2), seven varieties at Fort Collins (Table 4), and two varieties at Salinas (Table 5), that were no higher in root yield than the highest yielding sugarbeet check. Fodder beet varieties having highest yield at all locations are the same as those listed above for total sugar yield.

Sucrose Percentage: The mean sucrose percentage of fodder beets ranged from a low of 10.2 percent at Fargo (Table 7) to a high of 13.2 percent at Salinas (Table 5). All of the commercial sugarbeet check varieties had significantly higher sucrose percentage than the fodder beets at all locations (Tables 2 to 7). TC2018, Hugin, Lamono I, and Monorosa, were the fodder beets highest in sucrose percentage.

Reducing Sugar: Significant differences were observed for reducing sugars at all locations. The fodder beet varieties tended to have higher reducing sugar contents than the hybrid check varieties. However, reducing sugars contributed less than 10 percent to the overall total sugar yield, having a range from 0.07 percent (Table 5) to 0.87 percent (Table 7). Lamono II and Monovert were the fodder beet varieties with the highest reducing sugar.

Sodium and Potassium Content: Sodium and potassium content was significant at both Logan and Aberdeen locations. The fodder beets had slightly higher potassium, and 0.5 to 7 times the sodium content of sugarbeets.

Potential Alcohol Yield: Potential alcohol yield is calculated from the total sugar yield; therefore, the results are similar to the total sugar yield. Only the Logan and Fort Collins stations showed a significant difference between varieties for potential alcohol yield. Aberdeen, Salinas, and East Lansing locations showed average potential alcohol yield in excess of 870 gallons/acre (Tables 2, 4, and 6). Alcohol yield potential at Fargo (Table 7), averaged only 443 gallons/acre.

Table 1. Fodder beet and sugarbeet varieties in 1981 national cooperative research experiment.

Code No.	Variety	Origin	Ploidy	Germ	Root color
1	Lamono I	Sweden	2n	mm	White
2	Lamono II	Sweden	2n	mm	White
3	Kyros	Denmark	3n	mm	Yellow
4	Monovigor	France	3n	mm	Yellow
5	Barsein	Netherlands	3n	mm	White
6	Monriac	France	3n	mm	Yellow
7	Monorosa	Netherlands	2n	mm	Pink
8	Hugin	Denmark	3n	mm	White
9	Monovert	Netherlands	3n	mm	White
10	TC5/45-9	Netherlands	3n	mm	Yellow
11	Barb 79-1	Netherlands	3n	mm	Red
12	TC2018	Netherlands	3n	mm	Red
13	GWD2	U.S.	2n	mm	White
14*	Sugarbeet Check	U.S.	2n	mm	White
15*	Sugarbeet Check	U.S.	2n	mm	White
16*	Sugarbeet Check	U.S.	2n	mm	White

*Local check varieties for each location.

	Logan	Aberdeen	Fort Collins	Salinas	East Lansing	Fargo
14.	GWH149	GWH149	Zwaan Poly	USH11	USH23	Maribo Monova
15.	Beta 9421	Beta 9421	Beta 1237	Beta 9421	GW-Mono-Hy-E4	Beta 1839
16.	Hilleshog 309	Tasco 5376-02	GW-Mono-Hy-E4	Holly 7334-05	HH33	Hilleshog

Table 2. Root weight, sucrose percentage, reducing sugar percentage, sugar yield, and potential alcohol yield of sugarbeet and fodder beet hybrids in national cooperative fuel beet experiment, Logan, Utah, 1981.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Reducing sugar %	Total sugar %	Na ppm	K ppm	Potential alcohol yield Gal/A
Lamono I	109.5	94.9	11.22	.32	11.54	217	2785	698
Lamono I	118.8	102.3	11.08	.52	11.61	253	2912	757
Kyros	97.7	90.3	10.47	.35	10.81	240	3108	622
Monovigor	104.0	87.8	11.73	.27	12.00	216	3185	663
Barsein	102.2	85.4	11.60	.35	11.95	248	2650	651
Monriac	105.5	98.3	10.47	.31	10.78	191	2852	672
Monorosa	83.3	75.8	10.91	.28	11.18	189	2810	531
Hugin	93.7	79.2	11.59	.23	11.82	148	2740	597
Monovert	105.9	89.3	11.38	.42	11.80	247	2692	675
TC5/45-9	113.6	101.5	10.70	.49	11.19	223	3010	724
Barb 79-1	112.9	98.6	11.08	.40	11.48	205	3204	719
TC2018	105.8	87.0	11.86	.29	12.14	163	2264	674
GWD2	94.6	61.3	15.20	.23	15.43	37	1891	603
GW149	114.8	76.4	14.81	.23	15.04	51	2162	731
Beta 9421	101.7	66.4	14.99	.27	15.26	69	2350	648
Hilleshog 309	115.3	77.3	15.42	.29	15.72	102	2417	735
F Ratio	2.3*	6.5**	29.4**	13.6**	28.1**	23.0**	13.5**	2.3
LSD 0.05	17.5	13.6	0.95	.07	0.95	43	294	112
CV	14.3	13.9	6.7	17.9	6.5	21.3	9.4	14.3
Mean	104.9	85.5	12.16	.33	12.48	175	2690	668

Table 3. Root weight, sucrose percentage, reducing sugar percentage, sugar yield, and potential alcohol yield of sugarbeet and fodder beet hybrids in national cooperative fuel beet experiment, Aberdeen, Idaho, 1981.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Reducing sugars %	Total sugar %	Na ppm	K ppm	Potential alcohol yield Gal/A
Lamono I	150.8	133.9	11.14	.26	11.40	538	3410	961
Lamono II	151.7	138.6	10.68	.45	11.13	727	3304	967
Kyros	129.5	121.6	10.38	.31	10.69	582	3373	825
Monovigor	134.8	125.0	10.52	.27	10.79	560	3558	859
Barsein	134.0	118.6	10.93	.41	11.34	542	3100	854
Monriac	135.2	124.9	10.49	.39	10.88	531	3400	861
Monorosa	123.2	109.8	10.91	.46	11.37	582	3462	784
Hugin	125.3	108.3	11.42	.23	11.64	495	3340	798
Monovert	139.3	124.4	10.81	.40	11.22	659	3283	888
TC5/45-9	135.1	129.7	10.14	.32	10.46	640	3285	861
Barb 79-1	126.7	118.3	10.40	.40	10.81	558	3400	807
TC2018	129.5	107.0	11.81	.26	12.07	438	3002	825
GWD2	150.5	90.0	16.29	.26	16.55	223	2664	959
GW149	142.6	92.9	15.19	.20	15.39	174	2802	909
Beta 9421	145.4	91.8	15.64	.16	15.80	124	2725	926
TASCO 5376-02	139.3	86.5	15.79	.30	16.10	143	2400	888
F Ratio	1.4ns	10.6**	32.8**	3.8**	32.1	12.7**	10.9**	1.4ns
LSD 0.05	21.5	13.9	1.11	.13	1.10	154	290	137
CV	13.5	10.6	7.9	34.4	7.6	28.2	7.9	13.5
Mean	137.1	114.1	12.04	.32	12.35	470	3156	874

Table 4. Root weight, sucrose percentage, reducing sugar percentage, sugar yield, and potential alcohol yield of sugarbeet and fodder beet hybrids in national cooperative fuel beet experiment, Fort Collins, Colo., 1981.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Reducing sugar %	Total sugar %	Potential alcohol yield Gal/A
Lamono I	98.8	88.4	10.83	.38	11.21	629
Lamono II	100.2	99.2	9.44	.83	10.27	638
Kyros	94.4	95.6	9.62	.45	10.07	601
Monovigor	111.8	97.5	11.17	.28	11.46	712
Barsein	91.0	81.8	10.85	.37	11.22	580
Monriac	96.6	96.9	9.75	.33	10.08	615
Monorosa	90.8	76.5	11.65	.26	11.92	579
Hugin	88.7	85.9	10.22	.24	10.46	565
Monovert	93.4	89.3	9.97	.53	10.50	595
TC5/45-9	101.4	100.4	9.91	.35	10.27	646
Barb 79-1	92.8	87.7	10.34	.37	10.71	591
TC2018	100.6	84.6	11.76	.25	12.00	641
GWD2	97.9	59.0	16.41	.24	16.65	624
GW-Mono-Hy-E4	109.6	75.0	14.41	.24	14.65	698
Beta 1237	103.8	61.8	16.58	.24	16.82	661
Zwaan Poly	88.5	53.5	16.63	.21	16.84	564
F Ratio	2.56**	9.5**	19.7**	15.1**	19.72**	2.56**
LSD 0.05	12.1	13.3	1.65	0.13	1.60	77
CV	10.8	14.0	12.2	30.0	11.4	10.8
Mean	97.5	83.3	11.84	0.38	12.20	621

Table 5. Root weight, sucrose percentage, reducing sugar percentage, sugar yield, and potential alcohol yield of sugarbeet and fodder beet hybrids in national cooperative fuel beet experiment, Salinas, Calif., 1981.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Reducing sugar %	Total sugar %	Potential alcohol yield Gal/A
Lamono I	139.3	117.7	11.68	.18	11.86	888
Lamono I	144.6	123.2	11.50	.20	11.70	921
Kyros	136.2	126.1	10.53	.21	10.75	868
Monovigor	159.4	137.4	11.52	.11	11.63	1016
Barsein	138.4	109.8	12.38	.21	12.60	882
Monriac	136.1	117.3	11.47	.15	11.61	867
Monorosa	138.4	104.9	13.08	.12	13.21	882
Hugin	141.6	113.1	12.37	.13	12.50	902
Monovert	148.7	118.2	12.42	.20	12.61	947
TC5/45-9	155.0	141.4	10.82	.18	10.99	988
Barb 79-1	147.1	119.4	12.17	.18	12.34	937
TC2018	129.9	102.7	12.53	.11	12.64	828
GWD2	155.4	87.4	17.65	.13	17.78	990
USH11	144.5	86.7	16.60	.07	16.67	921
Beta 9421	144.1	87.0	16.52	.11	16.63	918
Holly 7334-05	163.7	91.2	17.85	.10	17.95	1043
F Ratio	1.5ns	10.8**	46.6**	5.3**	45.5**	1.5ns
LSD 0.05	21.3	14.7	1.02	.05	1.01	136
CV	12.7	11.5	6.7	31.9	6.5	12.7
Mean	145.1	111.5	13.19	.15	13.34	924

Table 6. Root weight, sucrose percentage, reducing sugar percentage, sugar yield, and potential alcohol yield of sugarbeet and fodder beet hybrids in national cooperative fuel beet experiment, East Lansing, Mich., 1981.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Reducing sugar %	Total sugar %	Potential alcohol yield Gal/A
Lamono I	100.11	89.69	11.05	.18	11.23	941
Lamono II	92.30	84.60	10.47	.43	10.90	861
Kyros	94.54	89.16	10.39	.21	10.60	878
Monovigor	95.95	86.36	10.92	.24	11.15	868
Barsein	88.08	78.09	10.98	.28	11.25	815
Monriac	94.10	85.92	10.77	.18	10.94	875
Monorosa	89.38	75.84	11.57	.17	11.74	852
Hugin	100.18	85.88	11.56	.14	11.70	922
Monovert	102.31	91.37	10.91	.30	11.21	952
TC5/49-9	91.33	94.96	10.57	.18	10.75	823
Barb 79-1	88.00	78.96	10.91	.21	11.12	808
TC2018	91.59	76.83	11.75	.17	11.92	846
GWD2	93.49	60.21	15.43	.10	15.53	854
USH23	95.68	61.81	15.35	.13	15.49	1013
GW-Mono-Hy-E4	87.75	57.13	15.22	.12	15.34	845
HH33	101.28	62.39	16.05	.18	16.23	966
F Ratio	1.0ns	7.81**	104.4**	6.1**	104.4**	1.2ns
LSD 0.05	13.7	11.61	0.57	0.09	0.56	147
CV	12.6	12.9	4.1	40.1	3.9	14.4
Mean	94.13	78.07	12.12	.20	12.32	882

Table 7. Root weight, sucrose percentage, reducing sugar percentage, sugar yield, and potential alcohol yield of sugarbeet and fodder beet hybrids in national cooperative fuel beet experiment, Fargo, N. Dak., 1981.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Reducing sugars %	Total sugar %	Potential alcohol yield Gal/A
Lamono I	69.24	78.2	8.27	.58	8.84	411
Lamono II	76.63	79.7	8.85	.87	9.71	449
Kyros	72.91	76.0	9.08	.54	9.62	438
Monovigor	68.85	76.6	8.50	.50	8.98	415
Barsein	67.12	66.1	9.55	.62	10.17	402
Monriac	74.59	79.5	9.01	.40	9.41	455
Monorosa	67.90	67.8	9.68	.37	10.05	417
Hugin	72.48	71.1	9.77	.41	10.18	443
Monovert	68.14	69.1	9.23	.65	9.88	406
TC5/45-9	81.80	80.4	9.60	.47	10.06	497
Barb 79-1	72.91	73.5	9.42	.49	9.92	442
TC2018	70.31	70.9	9.56	.36	9.92	432
GWD2	77.16	56.9	13.33	.31	13.64	480
Hilleshog 309	73.66	56.3	12.74	.35	13.09	457
Maribo Monova	77.22	54.9	13.80	.32	14.12	481
Beta 1839	75.51	57.5	12.76	.38	13.14	467
F Ratio	1.15 ns	10.0**	18.6**	4.7**	18.4**	1.33ns
LSD 0.05	10.8	8.0	1.17	0.18	1.14	70
CV	12.9	10.0	10.1	35.3	9.3	13.8
Mean	72.9	69.7	10.20	.47	10.67	443

Discussion

The results of 1981 tests were similar to those of the 1980 tests and conclusions are about the same for each year. There were only a few cases wherein the highest sugar producing fodder beet significantly outyielded the standard check GWD2. None of the fodder beets had a higher yield than the best sugarbeet hybrid at any location. Thus, if we were to recommend a beet for biomass and alcohol fuel production today, we would recommend a good sugarbeet hybrid adapted to the specific location where the crop is to be grown.

Fodder beets generally had significantly higher root weight and lower sugar percentage than the sugarbeets. Thus the current sugarbeet hybrid would also be more favorable than current fodder beet varieties as a fuel crop because less mass would have to be transported to the processing facility.

Data confirmed last year's finding that reducing sugar contributes less than 1 percent to the total sugar yield. It may be that fodder beets have higher reducing sugar than do sugarbeets, simply because more sucrose has been inverted in these beets prior to sugar analysis than in the sugarbeets.

We have again demonstrated that beets can produce in excess of 900 gallons/acre of alcohol based on an 85 percent conversion factor and assuming that 14 pounds of sugar is required to make a gallon of alcohol.

While none of the fodder beet or fodder beet hybrid varieties from Europe show a greater potential than our current sugarbeet varieties for biomass production, we believe that there is yet good potential for developing a fuel beet through breeding.

B. INTERMOUNTAIN REGIONAL TRIAL OF EUROPEAN FODDER BEET VARIETIES

Eleven European fodder beet hybrids and an open-pollinated fodder beet check variety (Camobarres) were evaluated with 3 to 4 commercial sugarbeet hybrids at four locations in 1981. The locations and cooperating scientists in the tests are given below:

Location	Cooperating Scientist
Logan, Utah	
Aberdeen, Idaho	Dr. John Gallian, University of Idaho Sugarbeet Extension Specialist
Rexburg, Idaho	
Kimberly, Idaho	Dr. J. R. Stander, Breeder, Beta Seed Inc.

A high-yield experimental selection from the Ames world collection, g241, was also included in the field trials at all locations except Kimberly. Three hybrids made by Dr. John Gallian, by crossing the CMS parents of UI1, UI3, and AH10 with the European fodder beet variety, Yellow Daeno, were included in the Aberdeen test. Varieties with their salient characteristics are listed in Table 8.

Table 8. Fodder beet and sugarbeet varieties in 1981 Intermountain Regional Test, 1981.

Variety	Origin	Ploidy	Germ	Root Color
Trestel	France	3n	mm	Pink
TC1157	Netherlands	3n	mm	White
Monosrover	France	3n	mm	White
Monofix	France	3n	mm	Red
Kimono	France	3n	mm	Pink
Monoblanc	Netherlands	3n	mm	White
Lamono I	Sweden	2n	mm	White
Krake	Denmark	2n	mm	White
Cimarosa	France	3n	MM	Pink
Barb 79-2	Netherlands	3n	mm	Yellow-Orange
Monorosa	Netherlands	2n	mm	Pink
Camobarres	Germany	2n	MM	Orange
GWD2	U.S.	2n	mm	White
GWH149	U.S.	2n	mm	White
Beta 9421	U.S.	3n	mm	White
g241	U.S.	2n	MM	Red-Yellow-White
TASCO 3576-02	U.S.	2n	mm	White
UI1♀CMS X Y. Daeno	U.S.	2n	MM	Yellow-White
UI3♀CMS X Y. Daeno	U.S.	2n	MM	Yellow-White
AH10♀CMS X Y. Daeno	U.S.	2n	MM	Yellow-White

All tests consisted of 4-row plots with the rows spaced 56 cm apart and 6 meters long. Each experiment was planted in a random block design of 6 replications. Harvest and laboratory determinations for root yield, sugars, and impurity factors were the same as those stated for the Logan station in the previous section of this report.

Results and Discussion

Excellent stands and little curly top disease was noted at all locations. At Logan, a weekly spraying for curly top with malathion was made as a preventative measure.

The sugar yield, root weight, sucrose percentage impurity factors, and potential alcohol yield for these tests are listed in Table 9 for Logan, Table 10 for Rexburg, Table 11 for Kimberly, and Table 12 for Aberdeen. Significant differences were noted at all locations for all of the characteristics that were measured.

Total Sugar Yield: The fodder beet variety having the highest sugar yield at each location except one (Table 11) was not significantly superior to GWD2 or the highest yielding sugarbeet check in the test (Tables 9 to 12). At Kimberly, however, (Table 11) Monofix significantly outyielded GWD2. Three fodder beet varieties at Rexburg (Table 10) and four at Aberdeen (Table 11) were significantly

lower than GWD2 in sugar yield.

Root Yield: Monosrover and Lamono I were the fodder beet varieties that consistently had the highest root weight (Tables 9 to 12). Camobarres was the highest root weight variety at Aberdeen (Table 12) as it was in 1980, but it didn't yield well at the other locations. Monofix also had outstanding root weight at Kimberly (Table 11) but not at the other locations. All varieties at Logan except Krake and Beta 9421 had significantly greater root weight than GWD2 (Table 9). At Kimberly, the fodder beets were all significantly higher in root yield. At Rexburg (Table 10) and Aberdeen (Table 12), only three and four varieties, respectively, were higher yielding than the GWH149 check.

Sugar Percentage: The sugar percentage at Kimberly was far lower than expected with the check varieties averaging only 13.7 percent sucrose (Table 11). At Aberdeen (Table 12), sucrose percentages were high, averaging 18 percent for the three checks. The sugarbeet checks were significantly higher in sucrose percentage than any of the fodder beets at three of the locations (Tables 9 to 11). However, at Aberdeen two sugarbeet X fodder beet hybrids, UI3♀CMS X Yellow Daeno, and AH10♀CMS X Yellow Daeno had sucrose percentages as high as the check.

Reducing Sugar: Reducing sugars were less than 1 percent as observed for the varieties in the national test. Some varieties were significantly higher and several were equal in reducing sugar to the sugarbeet checks. Camobarres, Barb 79-2, and TC1157 were significantly higher than the sugarbeet checks.

Sodium and Potassium Content: The fodder beets were generally a little higher in potassium and significantly higher in sodium, ranging in magnitude of 1 to 6 times that of the highest sugarbeet check for the latter quality factor.

Potential Alcohol Yield: The potential alcohol production was significantly higher for the Aberdeen location than the other three test sites (Table 12 vs. Table 9, 10, 11). Similar comparative data was observed in the national trials in 1981 and also in national and field trials in 1980. At three locations, the entries averaged 630+ gallons/acre (Tables 9, 10, 11), while at Aberdeen the varieties averaged over 900 gallons/acre. None of the fodder beet hybrids at any of the locations were significantly better for alcohol production than the best sugarbeet check.

In summary, the data from different varieties in the regional tests shows the same response as those in the national field trials. Again we would conclude that there is no advantage in growing current European fodder beet or sugarbeet X fodder beet hybrids for fuel. Current sugarbeet hybrids show better promise today with their adaptation and disease resistance as a fuel crop.

Table 9. Root weight, sugar percentages, sugar yield, quality factors, and potential alcohol yield, regional test, Logan, Utah, 1981.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Reducing sugars %	Total sugar %	Na ppm	K ppm	Potential alcohol yield Gal/A
Trestel	113.2	81.5	13.8	.26	14.01	303	2810	721
TC1157	116.1	89.6	12.5	.48	12.96	416	2537	740
Monosrover	117.7	96.3	11.9	.43	12.26	364	2989	750
Monofox	108.1	80.6	13.2	.30	13.45	206	2306	689
Kimono	101.1	77.5	12.6	.50	13.05	465	2620	644
Monoblanc	100.7	78.6	12.4	.46	12.84	368	2772	642
Lamono I	97.4	79.6	11.9	.40	12.27	398	2850	621
Krake	101.0	71.9	13.8	.35	14.14	259	2395	644
Cimarosa	118.0	77.5	14.8	.37	15.20	306	2558	752
Camobarres	84.8	86.0	9.1	.71	9.88	351	3293	540
Barb 79-2	93.3	92.8	9.5	.73	10.18	486	3012	594
Monorosa	99.3	78.9	12.2	.39	12.56	277	2656	633
Beta 9421	112.7	67.3	16.4	.34	16.78	121	2214	718
GWD2	104.9	60.9	16.9	.30	17.21	90	2108	668
g241	113.4	89.1	12.4	.37	12.81	333	2600	723
F Ratio	1.8*	2.5**	37.9**	12.6**		16.2**	8.8**	1.8*
LSD 0.05	20.7	16.9	1.0	.11		79	303	132
CV	17.2	18.3	6.8	22.1		21.8	10.0	17.2
Mean	105.4	80.5	12.9	.43		317	2648	672

Table 10 Root weight, sugar percentages, sugar yield, quality factors, and potential alcohol yield, regional tests, Rexburg, Idaho, 1981.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Reducing sugars %	Total sugar %	Na ppm	K ppm	Potential alcohol yield Gal/A
Trestel	95.4	78.8	11.88	.23	12.11	282	2877	608
TC1157	87.9	72.0	11.90	.31	12.20	349	2995	560
Monosrover	113.3	91.1	12.30	.23	12.53	312	3269	722
Monofix	101.1	78.8	12.68	.18	12.86	251	2904	644
Kimono	98.4	87.3	11.05	.27	11.32	460	3138	627
Monoblanc	91.7	77.9	11.29	.36	11.65	358	3083	584
Lamono I	115.4	92.5	12.27	.29	12.55	268	3175	735
Krake	98.7	78.2	12.41	.24	12.65	268	2940	629
Cimarosa	113.7	83.6	13.37	.25	13.63	214	2779	724
Camobarres	80.9	84.4	9.23	.52	9.75	309	3427	515
Barb 79-2	82.6	84.9	9.45	.35	9.85	377	2965	526
Monorosa	94.6	75.7	12.34	.24	12.58	349	3267	603
Beta 9421	105.8	67.5	15.54	.21	15.75	72	2273	674
GWD2	113.7	68.4	16.45	.20	16.64	66	2462	724
g241	93.9	82.8	11.21	.24	11.45	262	3123	598
GW149	115.8	72.4	15.88	.20	16.08	50	2315	738
F Ratio	2.8**	2.0*	24.0**	6.3**	24.2**	6.7**	2.8**	1.2ns
LSD 0.05	19.9	14.8	1.32	.10	1.14	132	370	127
CV	17.1	16.2	8.2	30.6	7.4	42.9	10.8	17.1
Mean	100.2	79.7	12.45	.27	12.73	266	2936	42

Table 11. Root weight, sugar percentages, sugar yield, quality factors, and potential alcohol yield, regional test, Kimberly, Idaho, 1981.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Reducing sugars %	Total sugar %	Na ppm	K ppm	Potential alcohol yields Gal/A
Trestel	103.6	95.9	10.68	.15	10.83	737	2431	660
TC1157	9.17	94.1	9.28	.48	9.76	811	2225	584
Monosrover	105.3	112.6	9.05	.32	9.36	926	2535	671
Monofix	113.9	98.6	11.47	.24	11.70	785	2635	726
Kimono	98.7	99.3	7.56	.42	9.98	935	2481	629
Monoblanc	97.8	91.3	10.46	.41	10.88	626	2406	623
Lamono I	99.0	104.2	9.05	.45	9.50	885	2500	631
Krake	105.5	92.2	11.27	.23	11.49	600	2458	672
Cimarosa	98.4	86.3	11.15	.28	11.42	601	2548	627
Camobarres	88.7	105.6	7.65	.78	8.42	806	2787	565
Barb 79-2	103.8	126.1	7.58	.64	8.23	885	2233	661
Monorosa	94.4	91.1	10.04	.34	10.38	663	2620	601
Beta 9421	97.5	72.7	13.22	.20	13.42	390	2435	621
GWD2	90.5	63.4	14.06	.20	14.26	273	2164	577
TASCO 3576-02	89.9	66.0	13.47	.20	13.64	333	2133	573
GW149	105.8	74.8	14.02	.18	14.20	220	2167	674
F Ratio	5.2**	35.9**	29.4**	21.4**	21.4**	13.8**	4.5**	5.2**
LSD 0.05	8.7	7.8	1.09	0.11	1.06	181	257	55
CV	7.6	7.4	8.7	27.2	8.2	23.8	9.1	7.6
Mean	99.1	92.1	10.75	.35	11.09	654	2423	631

Table 12. Root weight, sugar percentages, sugar yield, quality factors, and potential alcohol yield, regional test, Aberdeen, Idaho, 1981.

Variety	Total sugar dt/ha	Root yield t/ha	Sucrose %	Reducing sugars %	Total sugar %	Na ppm	K ppm	Potential alcohol yield Gal/A
Trestel	149.6	100.6	14.7	.26	14.97	631	2747	953
TC1157	134.8	97.8	13.4	.43	13.82	924	2650	859
Monosrover	146.6	116.4	12.4	.29	12.68	1031	3131	934
Monofix	145.9	96.7	14.9	.23	15.14	663	2825	930
Kimono	136.7	101.0	13.3	.43	13.69	1066	2943	871
Monoblanc	142.2	101.6	13.7	.32	14.04	930	2868	906
Lamono I	159.5	118.7	13.2	.32	13.51	968	2970	1016
Krake	161.6	96.7	16.5	.27	16.82	434	2716	1030
Cimarosa	145.6	90.3	15.8	.27	16.07	640	2793	928
Camobarres	128.7	123.1	9.7	.80	10.46	970	3200	820
Barb 79-2	117.7	117.8	9.5	.72	10.22	1111	2804	751
Monorosa	143.8	95.4	14.8	.26	15.05	646	2800	916
Beta 9421	152.1	87.9	17.1	.29	17.37	393	2525	969
GWD2	155.6	81.9	18.7	.28	18.98	236	2214	991
g241	130.1	97.8	13.0	.31	13.33	616	2679	829
GW149	161.5	86.9	18.3	.27	18.60	210	2277	1029
UI1 X Yellow Daeno	123.3	85.1	14.2	.23	14.46	747	2910	786
UI3 X Yellow Daeno	148.2	91.1	16.0	.28	16.28	583	2795	944
AH10 X Yellow Daeno	135.6	84.9	15.8	.34	16.11	513	2714	864
F Ratio	2.6**	5.4**	29.1**	8.3**	27.9**	12.2**	4.80**	2.6**
LSD 0.05	21.1	14.9	1.2	.15	1.23	217	306	134
CV	13.4	13.2	7.7	37.8	7.3	27.4	9.8	13.4
Mean	143.1	96.4	14.5	.35	14.8	701	2767	912

C. SWEET SORGHUM TRIAL 1981

Soil Type - Farmington sandy loam

Fertilizer - 0

Planting Date - 5/8/81

Irrigation - Furrow, approximately one inch per irrigation on a weekly basis beginning June 3 and ending September 15, 1981

Earliest heading dates - RIO and Mn 1500 began heading 8/29/81

Relative maturity from early to late -

1. RIO
2. Mn 1500
3. Dale
4. Keller
5. Mer 71-1 (variation in maturity)
6. Wray

Harvested - 10/2/81

Notes: 1) A heavy infestation of aphids appeared in early August, but disappeared in early September. The reason for their disappearance is unknown. It could be due to natural predators or a sudden change in climatic conditions.

2) Heavy winds (up to 60 mph) in early August caused considerable lodging.

This was the third year of a program to evaluate sweet sorghum as a potential fuel alcohol crop in the Intermountain Area. Last year (1980), the trial was planted at Logan, Utah. Because of a shorter growing season at Logan and an early frost, no varieties produced seed in the 1980 trial. Highest sugar concentration in the stalk is usually around the soft dough stage. Therefore, the yields and stalk soluble solids content were low in the 1980 trial.

The 1981 trial had a longer, more favorable growing season and all varieties flowered. Even the latest varieties had some seed in the early, soft dough stage. The earliness of the varieties is reflected in the seed yield (Tables 1 and 2) with RIO and Mn 1500 being the earliest and Mer 71-1 and Wray the latest.

There were significant differences in height and diameter. The tallest varieties were generally the smallest in diameter (Keller) and the smallest were the largest in diameter (Wray and Mer 71-1) (Table 1). Significant differences were noted between varieties for all measured characters except total dry weight yield and non-soluble dry weight yield. Keller gave the highest percent soluble solids and soluble solids yield. Wray was the highest yielding variety in both stalks and leaves, but because of its low percent dry weight and percent soluble solids, it was not the highest in total dry weight

Table 1. Stalk % soluble solids, % non-soluble solids, % dry weight, height, and diameter, and percentages of stalk, leaves, and seeds for each variety.

	Stalk			Total				
	Soluble solids %	Non-soluble dry weight %	Dry wt %	Stalk %	Leaves %	Seed head %	Max height inches	Diameter stalk center inches
Dale	12.5	11.28	23.78	80.91	12.46	6.63	127.0	.577
Keller	16.2	10.82	27.02	81.57	13.99	4.44	126.5	.514
RIO	15.4	13.63	29.05	76.90	14.14	8.96	111.8	.630
Wray	12.1	9.84	21.89	81.93	14.81	3.30	115.3	.666
Mer 71-1	11.4	11.41	22.78	77.32	16.68	6.15	124.5	.572
Mn 1500	15.1	10.36	25.46	78.46	9.96	11.58	114.8	.606
LSD 0.05	1.9	1.59	2.36	3.40	3.26	3.20	8.9	.068
F Ratio	10.58**	6.14**	11.90**	3.85**	4.42*	3.85*	5.27**	2.74*
CV	9.0	9.4	6.3	2.8	15.8	2.8	4.9	7.6

Table 2. Yield of total plant, stalk, leaves and seed, and stalk yields of total dry weight, non-soluble dry weight and soluble solids for each variety.

					Stalk		
	Total T/A	Stalk T/A	Leaves T/A	Seed head T/A	Total dry wt. T/A	Non-soluble dry weight T/A	Soluble solids Lbs/A
Dale	32.03	25.90	3.99	2.15	6.17	2.93	6,491
Keller	27.27	22.26	3.80	1.21	6.03	2.41	7,249
RIO	24.91	19.24	3.49	2.99	5.50	2.61	5,907
Wray	35.53	29.13	5.23	1.19	6.38	2.89	6,976
Mer 71-1	29.90	23.09	4.99	1.87	5.27	2.65	5,236
Mn 1500	25.62	20.08	2.58	2.96	5.12	2.09	6,067
LSD 0.05	5.03	4.22	1.01	1.24	1.17	0.75	1,177
F Ratio	5.98**	6.99**	8.64**	3.80*	1.77ns	1.54ns	3.58*
CV (%)	11.4	12.0	16.6	39.8	13.6	19.4	12.3

or soluble solids yield (Tables 1 and 2). A high proportion of the soluble solids in the stalk is sugar (the feedstock of fermentation); therefore, Keller appears to be the most promising variety for alcohol fuel production in the Intermountain Area. It does, however, have some disadvantages. It is borderline in maturity for this area and its tall, small diameter stalk makes it extremely susceptible to lodging.

VIII: PHYSIOLOGY - BIOCHEMISTRY

Roger E. Wyse

IMPORTANCE OF SUCROSE TRANSPORT IN THE SUGARBEET TAPROOT AND ITS POTENTIAL CONTROL WITH BIOREGULATORS

Introduction

Sucrose is synthesized in the sugarbeet leaf as one of the early products of photosynthesis. It is then transported throughout the plant to developing organs including the taproot. The pattern of sucrose allocation determines yield and sucrose content. Therefore, understanding the basic mechanisms controlling sucrose allocation will provide an understanding of the factors controlling yield and sucrose content in sugarbeet. Once this basic information is known, we anticipate developing more efficient selection criteria for identifying superior genotypes or to utilize bioregulators to manipulate sucrose allocation.

Sucrose is actively loaded into the vascular system (phloem) in the leaf where it moves to developing organs (sinks) with the highest priority and/or greatest growth potential. A sucrose concentration gradient is established within the phloem, and it is this concentration gradient that regulates flux rates to developing sinks. This vascular system is analogous to water moving through a pipe system. Water will flow to the lowest point in the system. Therefore, sinks which can maintain the lowest concentration of sucrose at the site of phloem unloading will be those sinks with highest priority for sucrose. Our present understanding of phloem unloading in the sink suggests that the sucrose moves out of the phloem to the cell wall free space where it is actively taken up by the storage cells. Therefore, we have concentrated our research on the mechanism of phloem unloading and the active transport of sucrose into developing storage cells.

Young roots and other developing organs contain a very active cell wall acid invertase. Therefore, as sucrose moves out of the phloem, it is quickly hydrolyzed to glucose and fructose, and it is the monosaccharides which are transported across the outer plasma membrane of the cell. Later as the taproot tissue matures, sucrose itself is transported across the outer plasmalemma membrane.

In the intact plant system the concentration of sucrose in the cell wall of mature taproot tissue is 20-40 mM. At these concentrations the primary mode of uptake is passive (Fig. 1). Therefore, sucrose is moving into the cytoplasm by simple diffusion and is not under direct metabolic control by the cell.

Conversely glucose uptake across the outer membrane is primarily by an active process (Fig. 2)--a process which saturates very quickly at low external concentration.

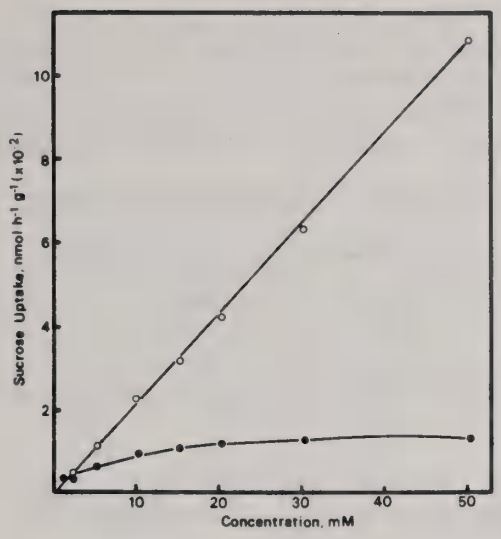

Figure 1. Effect of Sucrose Concentration on Short-Term Sucrose Uptake by Sugarbeet Root Discs. (○) - Passive, (●) - Active.

Discs (1 X 6 mm) were cut from sugarbeet taproot tissue using a hand microtome and sharp cork-borer. The discs were then washed for 90 min in a 200 mM mannitol, 1 mM $CaCl_2$ solution with aeration. Discs were incubated for 1 h in 30 mM MOPS (pH 6.0), 1 mM $CaCl_2$, and sufficient mannitol to balance the osmotic concentration of [^{14}C]-sucrose plus mannitol at 200 mM. CCCP (5 µM) was used to differentiate between active (CCCP sensitive) and passive (CCCP insensitive) uptake. After incubation the discs were washed 3 X 3 min to remove free space sugars and then extracted with hot 80% EtOH. [^{14}C]-label in the ethanol extract was quantified by liquid scintillation spectroscopy.

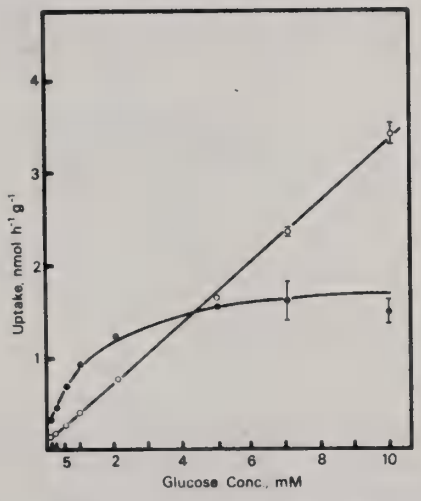

Figure 2. Effect of Glucose Concentration on Short-Term Glucose Uptake by Sugarbeet Root Discs. (○) - Passive, (●) - Active.

Experimental protocol was as described in Figure 1.

Sucrose movement across the outer membrane taproot storage cells is pH dependent (Fig. 3). Both glucose and sucrose are taken up more rapidly at lower pH. This suggests that the driving force for the active uptake is the co-transport of a proton with sucrose. The proton gradient from the outside cell wall to the inside of the cytoplasm provides the energy necessary to drive the uptake of sucrose.

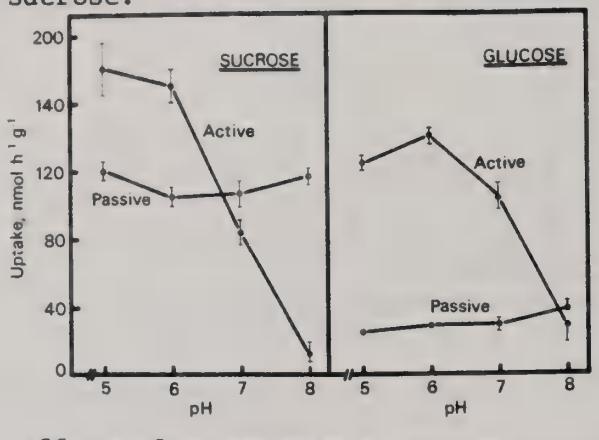

Figure 3. Effect of pH on uptake of Sucrose and Glucose in Short-term Experiments.

Experimental protocol was as described in Figure 1. Mes buffer was used at pH 5 and 6, MOPS at pH 7 and 8. The tissue was incubated for 1 h in either 5 mM [^{14}C]-sucrose or 1 mM [^{14}C]-glucose.

Important to sugarbeet productivity is the movement of sucrose into the storage vacuole. This is an active process because sucrose is concentrated from a low concentration on the outside to a high concentration inside the vacuole. This active transport process shows more complicated kinetics. At low external concentrations the system starts to saturate, but then there is strong evidence for a carrier mechanism which is infinitely responsive to external concentrations (Fig. 4). We have previously shown the mechanism for transport of sucrose uptake into the vacuole to be via a potassium/sucrose co-transport system for the potassium gradient between the cytoplasm and vacuole drives the uptake of sucrose.

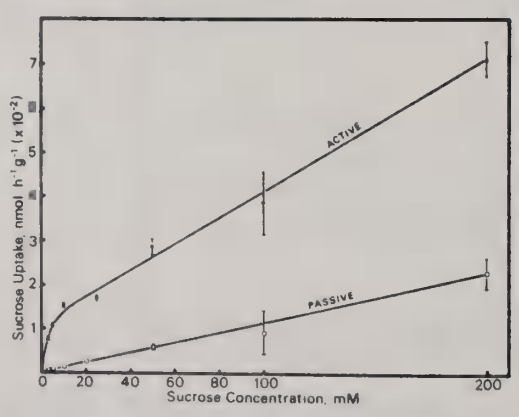

Figure 4. Effect of Sucrose Concentration on Long-Term Sucrose Uptake by Sugarbeet Root Discs. (○) - Passive, (●) - Active.

Experimental protocol was as described in Figure 1 with the following changes: Equilibrated discs were incubated for 4 h in 40 mM sucrose followed by washing for 3 X 30 min to remove free space and cytoplasmic sugars.

Important for the bioregulation of sucrose content in sugarbeet is the control of transport at the outer membrane and at the tonoplast by hormone and bioregulators. Recently we have acquired an experimental growth regulator which appears to be active in stimulating transport at both the plasmalemma and tonoplast membranes. Sugarbeet tissue discs were incubated in the bioregulator Mepiqual chloride ("Pix")and the uptake of sucrose monitored. The compound stimulated sucrose uptake by 33% at the plasmalemma (Table 1).

Table 1. Effect of "Pix" on Sucrose Transport at the Plasmalemma of Sugarbeet Root Disc Cells.

Treatment	Active Uptake nmol/gr/h	% Stimulation
Control	98	--
1 ppm	116	10
5 ppm	127	17
10 ppm	152	33
20 ppm	141	26

Discs were incubated in 5 mM sucrose for 1 h in the "Pix" solution indicated.

but more importantly stimulated sucrose transport into the vacuole by 45% (Table 2). This latter response is exciting because transport at the tonoplast results in sucrose accumulation in taproot tissue.

Table 2. Effect of "Pix" on Sucrose Transport at the Tonoplast of Sugarbeet Root Disc Cells

Treatment	Active Uptake nmol/gr/h	% Stimulation
Control	165.0	--
1 ppm	164.0	0.0
10 ppm	156.0	0.0
20 ppm	180.0	10
50 ppm	191.0	16
100 ppm	239.0	45

Discs were incubated at 40 mM sucrose for 4 h in the "Pix" solution indicated.

We are continuing studies on the effect of this growth regulator on sucrose storage. This preliminary evidence suggests that there are bioregulators available which can stimulate sucrose uptake, and it is now important to determine their efficacy in promoting sugar storage in a whole-plant system.

SUGARBEET RESEARCH

1981 Report

Section C

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ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION AND GERMPLASM RELEASES AND REGISTRATIONS, 1981

HECKER, R. J. and S. S. MARTIN. 1981. Effects of sugarbeet sample preparation and handling on sucrose, nonsucrose and purity analyses. J. Amer. Soc. Sugar Beet Technol. 21:184-197.

Several experiments were conducted to compare methods of sugarbeet sample preparation and preservation for sucrose and quality analyses. Samples treated with the preservative phenylmercuric acetate (PMA) were not different from controls for sucrose, refractive dry substance, raw juice purity, and thin juice purity (TJP). Among seven nonsucrose components of purity, amino nitrogen and conductivity ash were present in significantly lower quantity in the PMA treated samples. In separate experiments comparing fresh and frozen brei, sucrose contents of the two brei treatments were the same in beets grown at low, optimum, and excess nitrogen fertility. Three methods of juice extraction were found to have similar TJP. However, in two of three experiments the extracts had significantly lower TJP than standard limed pressed juice stored frozen. Differences among seven nonsucroses in the extracts were significant in some cases but not practically important. Each of the extracts studied should provide a reliable purity sample. Practically, the 1:1 frozen brei extract should provide an alternative method which permits an accurate assessment of the constitution and composition of beets. However, data from different extract types should not be compared numerically. The Na, K, and AMN contents of lead-clarified sucrose filtrate and brei extract were significantly affected by some filtrate storage treatments. However, high correlations among the different treatments indicated that the filtrate treatment may be immaterial provided the same juice and procedure were used consistently. Three methods of storing brei or limed juice samples all exhibited lower TJP than immediately analyzed juices. Glucose in 10 diverse cultivars ranged from 0.14% to 0.43 of fresh root weight. Sucrose measurements by polarization and gas chromatography were not different in any of these 10 cultivars.

HECKER, R. J. and E. G. RUPPEL. 1981. Release of sugarbeet germplasm FC 703/4.

FC 703/4 is a multigerm, pollen fertile sugarbeet (Beta vulgaris) resistant to root rot caused by Rhizoctonia solani and is moderately resistant to leaf spot caused by Cercospora beticola. It is a diploid ($2\chi = 18$) and self sterile. It is a product of two cycles of mass selection prior to flowering and one cycle of recurrent selection, with progeny testing, for rhizoctonia root rot resistance from FC 703 (resistant line released in 1976). Under very severe artificially-created epiphytotics in 1980 and 1981, FC 703/4 had an average of 49% harvestable roots, 21% symptomless roots, and a disease index of 3.1, compared to 47%, 14%, and 3.3 for FC 703 (resistant check), and 7%, 0%, and 6.1 for FC 901 (susceptible check), respectively. With a set of male sterile testers is has good general combining ability (better than FC 703) for root yield, sucrose content, and juice purity.

MARTIN, S. S. 1982. Alternative aluminum clarification procedure. Beet Sugar Technology, 3rd Edition (In Press)

The procedure for use of aluminum salts as extract clarificants for polarimetric sucrose determination is described.

RUPPEL, E. G. and R. J. HECKER. 1982. Increased severity of rhizoctonia root rot in sugar beet treated with systemic insecticides. Crop Prot. 1:107-113.

The systemic insecticides aldicarb 15G (15% granules) at 2.6 kg and phorate 10G (10% granules) at 1.7 kg active ingredient (a.i.)/ha, applied as side dressings about 1 month after planting in 1979 and 1980, significantly increased the severity of root rot, caused by Rhizoctonia solani Kühn, in sugarbeet (Beta vulgaris L.). Carbofuran 10G (10% granules) at 2.2 kg a.i./ha also increased root rot, but not significantly. Numbers of harvestable roots were reduced by all treatments but significantly by phorate only. Both aldicarb and phorate were slightly fungistatic to R. solani when the pathogen was grown on potato-dextrose agar incorporating 0.5, 5.0, and 25 µg a.i./ml. Trichoderma sp., a potential antagonist of Rhizoctonia, was slightly inhibited by aldicarb and phorate initially, but soon overcame the effect. Thus, the increase in disease severity in the field may be attributable to some metabolic or physiological effect of the chemicals either on the host or on the infection process of the pathogen. Indiscriminate use of these insecticides should therefore be avoided in areas where root rot is prevalent but insects are not a problem.

SCHNEIDER, C. L., E. G. RUPPEL, R. J. HECKER and G. J. HOGABOAM. Effect of soil deposition in crowns on development of rhizoctonia root rot in sugarbeet. Plant Dis. (In press)

Some growers follow cultivation practices that result in soil deposition in and around sugarbeet crowns (hilling). Our greenhouse and field experiments show that hilling aggravates root rot in soils infested with Rhizoctonia solani. In the greenhouse, hilled plants developed root rot sooner and with greater degree of severity than unhilled plants. In field plots at two locations, hilling, in two of three experiments, significantly increased root rot incidence and severity in resistant as well as in susceptible cultivars.

SMITH, G. A., E. E. SCHWEIZER and S. S. MARTIN. 1982. Differential responses of sugarbeet populations to herbicides. Crop Sci. 22. (In Press)

Fifteen sugarbeet populations (Beta vulgaris L.) consisting of five inbred lines, five F_1 hybrids, and five commercial cultivars were evaluated two years for their response to certain herbicide regimes. The populations were assessed primarily by determining the nature and magnitude of first and second order interactions. The treatment regimes consisted of cycloate (3.4 kg/ha) or ethofumesate (2.2 kg/ha) applied preplant followed by a postemergence mixture of desmedipham and phenmedipham each applied at 0.6 kg/ha. A third treatment regime was that of no herbicide application. The 10 characters examined were: root weight, sucrose, purity, sodium, potassium, nitrate, betaine, amino N, chloride, and foliar suppression. Genetic control of the response to herbicide application was exemplified by significantly different population reactions for the majority of the 10 characters studies. When the entire array of 15 populations was analyzed, a significant year X population interaction was detected for eight characters. Further,

significant first order interactions were those of year X herbicide for root weight and herbicide X population for foliar suppression. No significant second order interactions were found. Several chemical components of juice, foliar suppression, and root weight showed significant first order interactions, but only in the group of five commerical cultivars. In general, root weight, sucrose, and purity were slightly reduced, whereas chloride, nitrate, and betaine were increased following herbicide application. The most prominent effect of herbicide treatment was suppression of foliar growth. Both pre- and postemergence treatment suppressed the population groups in the order: inbreds > F_1 hybrids > commercial cultivars.

Papers Which Have Been Published Since the Previous Sugarbeet Research Report

HECKER, R. J. and E. G. RUPPEL. 1981. Registration of FC 708 and FC 708 CMS Sugar Beet Germplasm (Reg. Nos. GP63 and GP64). Crop Sci. 21:802.

RUPPEL, E. G. Controlling preharvest fungal diseases of sugar beet, pp. 501-504. *In* Vol. II, Proc. Symposia IX Intern. Cong. Plant Prot., Washington, DC, Aug. 5-11, 1979. Amer. Phytopathol. Soc. 1981.

SMITH, G. A. 1981. New sugarbeet line bred to resist both leafspot and curly top. Sugar Y Azucar, 76:22

SMITH, G. A. and E. E. SCHWEIZER. 1981. Variety X herbicide interaction. Sugro Info. 3:1-6.

STEINKAMP, M. P., S. S. MARTIN, L. L. HOEFERT, and E. G. RUPPEL. 1981. Ultrastructure of lesions produced in leaves of Beta vulgaris by cercosporin, a toxin from Cercospora beticola. Phytopathology 71: 1272-1281.

RHIZOCTONIA ROOT ROT RESISTANCE AND RESISTANCE BREEDING (BSDF Project 20)

1981 Rhizoctonia Field Research.--R. J. Hecker and E. G. Ruppel

The 1981 Rhizoctonia root rot field research on sugarbeet supported by BSDF Project 20 was conducted on our BSDF-leased farm, where the cercospora leaf spot field research was also conducted.

The epiphytotic of root rot caused by *Rhizoctonia solani* in our inoculated 1981 nursery was quite severe, but ideal for our root rot assessments. The rhizoctonia root rot experiments were conducted on an area of the farm reserved for that purpose, where the experiments are grown in a 4-year rotation (beets, barley, barley, fallow). Four 1981 experiments (1R, 2R, 3R, and 4R) were located on a portion of the 1980 rhizoctonia field in order to have an area with high residual infestation of *Rhizoctonia*. The experiments in this residual inoculum area also received a preplant broadcast incorporated application of our standard ground barley-grain inoculum at 50 pounds per acre. These four experiments were planted April 27 and thinned June 4 and 5, and are described in succeeding sections of this report. The majority of the rhizoctonia field research area in 1981, involving seven experiments, was planted in an area that was last used for rhizoctonia research in 1977. There was no significant rhizoctonia infection in this 1981 nursery due to residual *Rhizoctonia* in the soil. These seven experiments were inoculated July 15. Dry, ground barley-grain inoculum of *R. solani* was broadcast in a band over each row with a tractor-mounted 4-row granule applicator. The inoculum rate was 1.9 grams per meter of row in a split application (opposite direction of travel for each application). Single-row plots, 6.1 meters (20 ft) long, and 56 cm (22 in) apart were planted May 14 and thinned about June 15.

Roots in all experiments were lifted and individually rated for severity of rot September 9 through 11. Disease index (DI) ratings were based on a scale of 0 to 7 (0 = no evidence of rot; 7 = plant dead and extensively decomposed). The percentage of healthy roots were those with index rating of 0 and 1, those roots having no or only small arrested lesions. The percentage of harvestable roots were those with DI ratings of 0 through 3; these were roots sufficiently sound to be recovered in a commercial harvest.

The succeeding reports in this section on BSDF Project 20 describe individual experiments in our 1981 rhizoctonia root rot research.

Evaluation of Contributed Lines.--E. G. Ruppel and R. J. Hecker

Separate randomized complete block designs with five replications were used to evaluate a total of 60 lines from American Crystal, Great Western, and Holly sugar companies, and from the Grower-Great Western Joint Research Committee for resistance to *Rhizoctonia solani* in the field. In each test, Rhizoctonia-resistant line FC 703 and highly susceptible line FC 901 were included for comparisons. Results of each contributor's test were statistically analyzed and sent to company breeders; thus, they will not be reproduced here. The mean disease indexes for FC 703 and FC 901 across tests were 2.9 and 6.1, respectively. The % healthy means were 26 and 0.4%, whereas % harvestable means were 66 and 6%, respectively.

Evaluation of Sugarbeet Lines in the Program of Breeding for Resistance to Root Rotting Strains of *R. solani*.--R. J. Hecker and E. G. Ruppel

From scattered reports, it appears that beet crop losses due to rhizoctonia root rot in 1981 generally were not as severe as in 1980. The variable intensity of this disease from year to year and from area to area sometimes reduces the concern for losses in sugarbeet production due to this ubiquitous root-rotting soil-borne fungus. Due to the year-to-year variability in the intensity of rhizoctonia root rot, growers are understandably reluctant to plant a variety that has some resistance but which may sacrifice some yield in the total absence of the disease.

Germplasms are being developed and released from our resistance breeding research that should be potentially useful in the development of resistant highly productive hybrid varieties. In 1981, FC 703/4 was officially released to BSDF members. This rhizoctonia-resistant multigerm is also moderately resistant to leaf spot. It is a diploid (2X = 18) and relatively self-sterile. Under severe epiphytotics in 1980 and 1981, FC 703/4 had an average of 49% harvestable roots, 21% symptomless roots, and a disease index of 3.1, compared to 47%, 14%, and 3.3 for FC 703 (standard resistant check), and 7%, 0%, and 6.1 for FC 901 (standard susceptible check), respectively. With a group of male sterile testors it had better general combining ability than FC 703 for root yield and recoverable sucrose, in the absence of disease. Its specific combining ability with certain male steriles was quite attractive, and its rhizoctonia resistance with these same male steriles was relatively good, as noted in a succeeding section of this report.

A previous resistant release from the breeding program (FC 702/6) was registered in 1981.

The most resistant multigerm breeding lines in our 1981 inoculated evaluation nursery are shown in Table 1. Entries 351, 311 and 324 are candidates for release in 1982. Other entries in Table 1 are various lines in the breeding program, and some that have already been released. The percent healthy data in Table 1 is the percentage of plants which are free of active rot. Although very variable (large LSD), the data indicate that, at best, only about one third of the plants in any entry are disease-free. The percent harvestable data, which includes plants rated in classes 0 through 3 and are roots that would be retained in a commercial harvest, indicate that varieties with resistance equivalent to the best lines would suffer no more than a 25 percent loss due to root rot. However, it must be kept in mind that the disease intensity in this inoculated nursery was undoubtedly much greater and certainly more uniform than any naturally occurring rhizoctonia infestation. It is likely that a commercial variety with a level of resistance equivalent to the best lines in Table 1 would withstand naturally occurring rhizoctonia infestations with little loss.

Resistant breeding lines that are monogerm or are segregating for monogerm are shown in Table 2. Some of these are quite attractive from a resistance standpoint. However, most of them are not very attractive agronomically. Monogerm releases besides FC 708 will be made as soon as possible. A number of diverse monogerm types are in earlier phases of our breeding program, but

any materials therefrom will not be available for several years. Meanwhile, the development of commercial hybrids with some degree of resistance can best be achieved by testing multigerm rhizoctonia releases from our program as pollinators on proven male sterile monogerm parents. In any relatively successful hybrid of this nature, a further increment of resistance could probably be gained by converting the resistant pollinator to the tetraploid (4χ) condition, which would then result in a triploid (3χ) hybrid variety. We have previously shown that triploids with two genomes from a resistant parent are usually more resistant than an equivalent diploid hybrid.

Table 3 gives the rhizoctonia resistance ratings of various materials from our continuing search in more exotic germplasms for potentially new sources of rhizoctonia resistance. It would appear that entires 377, 348, 349, 347, and 344, which are culinary and fodder beets, may have some inherent resistance. However, the fodder beet need significant further testing since they may be escaping the disease due to their aerial root growth habit. Most of the other entries in Table 3 are commercial lines that we had not previously tested.

We are currently in the process of converting FC 708 CMS and FC 708 (recent rhizoctonia resistant monogerm releases) to tetraploids (4χ). A few of our other most resistant germplasms in the breeding program are also destined for conversion to 4χ. However, this is a fairly time-consuming and expensive procedure.

A new technique of exposure of plants to rhizoctonia in both the root development and seed production phases appears to be fairly successful after two generations of such exposures. It appears that the second inoculation helps to eliminate some of the escapes that frequently occur following inoculation in the vegetative stage. However, the intensity of infection of stecklings or mother roots inoculated at transplanting in the spring has not been consistent from year to year. Infection in 1981, for example, was much less intense from this type of inoculation than it was in the two previous years.

Experience in our resistance breeding program reinforces our hypothesis that resistance to root rotting strains of *R. solani* is controlled by a number of genes. Our earlier genetic studies indicated that at least three major genes condition resistance, but our new evidence indicates there are considerable more genes involved. The calculated heritabilities for resistance have been low, and this is what our breeding experience also indicates. Even with relatively good methods of inoculation and disease exposure, there remain too many plants that must be escapes. In 1982 we plan some experiments on methods of inoculation which may help to identify the truly genetically resistant types and ultimately improve the efficiency of our resistance breeding program.

Each year in our breeding program we have been generating experimental hybrids between our resistant lines and monogerm male sterile testers. The productivity of these hybrids under disease-free conditions is reported in a subsequent section of this report. Further testing of any of these experimental hybrids by BSDF members is welcomed.

Table 1. Rhizoctonia resistance evaluation of multigerm breeding lines; disease index (DI), % healthy roots, and % harvestable roots (Exp. 5R 81).

Entry No.	Breeding line	DI	% healthy	% harvestable
351	FC 707/2	2.5	29	76
338	FC 705	2.5	31	76
325	Syn from FC 701/4 Phoma sels	2.6	23	75
321	FC 707	2.6	32	71
318	Source of FC 707/2	2.7	32	71
359	FC 701/6	2.7	22	75
311	Advanced FC 703	2.7	30	74
361	FC 705/2	2.7	26	78
371	FC 703/3	2.8	30	70
319	FC 706	2.8	23	67
309	Intermated Rh. resist. lines	2.8	26	68
370	FC 703/2	2.9	28	59
366	FC 702/6	3.0	26	59
372	FC 703/4	3.1	25	52
352	FC 707/1	3.1	19	59
367	FC 702/7	3.2	18	58
339	FC 709	3.2	11	66
324	Polycross from Japanese lines	3.2	10	58
328	FC 703 (4χ)	3.4	11	58
322	FC 801 PC_2	3.8	15	37
313	3d cy Rh. sel. fr. USSR MM pool	4.0	6	41
362	FC 702	4.1	10	38
308	1 cy sel. fr. FC 703 X high suc. lines	4.3	4	32
356	FC 701	4.7	1	17
316	FC 703; resistant check	3.3	21	58
341	FC 901; susceptible check	6.0	0	7
LSD (.05)		0.8	12	13

Table 2. Rhizoctonia resistance evaluation of monogerm breeding lines; disease index (DI), % healthy roots and % harvestable roots (Exp. 5R, 81).

Entry No.	Breeding line	DI	% healthy	% harvestable
331	A progeny from (FC 701 X mm, TO) BC_1P_2	1.9	48	91
327	Mono Syn. from (FC 701 X mm, TO) BC_1P_2	2.1	41	87
350	OP of S_1s from (FC 701 X mm, TO) BC_1P_2	2.4	30	80
355	FC 708 CMS (B_3)	2.5	28	79
305	FC 708 CMS (B_2)	2.6	34	77
353	FC 708	2.9	17	72
302	(FC 708 CMS X LSR, TO) F_2	4.1	8	43
301	(LSR, TO X FC 708) F_2	4.2	8	45
307	(FC 708 CMS X mm, TO from USSR mm's)	4.4	4	28
316	FC 703; resistant check	3.3	21	58
341	FC 901; susceptible check	6.0	0	7
LSD (.05)		0.8	12	13

Table 3. Rhizoctonia resistance of miscellaneous materials; disease index (DI), % healthy roots and % harvestable roots (Exp. 5R, 81).

Entry No.	Description	DI	% healthy	% harvestable
377	Pithium resist, culinary	2.5	20	90
375	Pithium resist, annual	6.5	1	4
348	A80-6; mm, 2χ, fodder beet	2.8	16	83
349	A80-31; mm 2χ, fodder beet	3.3	5	74
347	A80-7; mm, 2χ, fodder beet	3.6	7	64
344	A80-8; mm, 2χ, fodder beet	3.7	3	65
346	A79-90; mm, 2χ, fodder beet	5.9	0	11
336	ACH 139	4.8	2	12
334	HH 32	5.0	3	17
335	70 MSH 386	5.1	0	14
340	Mono Hy E4	6.1	0	2
342	Mono Hy E6	6.0	0	4
343	Mono Hy E7	6.2	1	4
383	Mono Hy A4	6.1	0	5
379	Mono Hy D2	6.0	2	6
382	SP 80320-0; B. maritima cyto.	6.6	0	6
381	SP 80320-02 CMS	6.3	0	1
380	Yellowleaf mutant	6.9	0	0
316	FC 703; resistant check	3.3	21	58
341	FC 901; susceptible check	6.0	0	7
LSD (.05)		0.8	12	13

Rhizoctonia Resistance of Hybrids Relative to Their Susceptible and Resistant Parents.--R. J. Hecker and E. G. Ruppel

Eight of the rhizoctonia resistant experimental hybrids that were included in the advanced test under disease-free conditions were also tested in the rhizoctonia nursery along with their susceptible female and resistant male parents (except in two cases where the female was not available). The disease indices and percent harvestable roots from this inoculated test are in Table 1. In this experiment we used single row 6.1 m (20-foot) plots with four replications in a randomized complete block design. All other methods were described in the first part of this section on *Rhizoctonia* research.

The mean disease index of these six experimental hybrids was 4.3, and the mean mid-parental value was 4.5. This indicates a slight amount of genetic dominance for resistance. Although this difference is not great, it is of the same magnitude as the difference between a different set of hybrids and their mid-parental values in 1980. In 1979, a similar test on a set of ten other hybrids had a mean hybrid index of 4.2 and a mid-parent value of 4.4 Hence, this slight degree of dominance for resistance is consistent over years and is probably real. The hybrids all tend to express this modest level of dominance for resistance. In recent years, we have detected only two experimental hybrids that showed great amounts of dominance for resistance, and no experimental hybrids that showed dominance for susceptibility. These two cases of strong dominance for resistance are being retested in 1982. Based on our limited set of 22 hybrids in 3 years of testing, it appears that there is a slight tendency toward dominance for resistance in hybrid combinations between susceptible male steriles and resistant diploid pollinators. Although this degree of dominance does not appear to be large, it nonetheless is operating to the advantage of the breeder who is trying to develop partially resistant hybrids. Evidence that we presented several years ago indicated that there would be additional improvement in resistance by doubling the pollinator to the tetraploid condition, resulting in hybrids with one genome from the susceptible parent and two genomes from the resistant parent.

Table 1. Rhizoctonia resistance evaluations of experimental hybrids, their susceptible male sterile parents (F) and their resistant pollinators (M); midparental values (MP) are also included.

Hybrid	Disease Index				% Harvestable			
	Hyb	MP	F	M	Hyb.	MP	F	M
(SLC 129 CMS X EL 44) X FC 703/4	4.6	4.9	6.5	3.4	17	24	3	46
(SLC 129 CMS X SP 73747-0) X FC 705	4.0	4.0	5.9	2.2	31	38	2	75
(652016s1 CMS X 662119s1) X FC 702/7	4.8	--	--	2.7	12	--	--	67
(SLC 129 CMS X EL 44) X FC 702/7	4.2	4.6	6.5	2.7	28	35	3	67
(SLC 129 CMS X French TO) X FC 703/4	4.4	4.6	5.9	3.4	24	26	5	46
(FC 604 CMS X Polish TO) X FC 702/7	4.2	4.2	5.7	2.7	30	40	12	67
(FC 604 CMS X Polish TO) X FC 703/4	4.2	4.6	5.7	3.4	31	29	12	46
(SLC 129 CMS X SLC 133) X FC 702/7	4.4	--	--	2.7	20	--	--	67
HH 32	4.8				21			
FC 901 (susc. ck.)	6.2				5			
FC 703 (resist. ck)	2.6				69			
LSD (.05)	0.8				11			
$\bar{X}$	4.3	4.5			27	32		

Effect of *Trichoderma* as a Biocontrol Agent of *Rhizoctonia* in the Field.--E. G. Ruppel, R. Baker, I. Chet, G. Harmon, and R. J. Hecker (cooperative study with the Botany & Plant Pathology Department, Colorado State University).

A randomized complete block design with four replications was used to test a fungal antagonist of *Rhizoctonia solani* for control of rhizoctonia damping-off and root rot in a field heavily infested with the pathogen. Plots were four rows wide and 4 m long with 56 cm between rows. Only the center two rows were treated and evaluated. Treatments included seed treatment with *Trichoderma harzianum*, seed treatment with *T. harzianum* plus chitin, a preplant in-row treatment with *T. harzianum* (about 8 X 10^3 propagules/g soil within a 4 x 4-inch band), a preplant in-row treatment with *T. harzianum* plus 4.0 mg EDTA/4-m row, seed treatment with maneb fungicide, and a nontreated control. Seed treated with *Trichoderma* were soaked in a 10% (w/v) 'Pelgel' (Nitragin Co., Inc., Milwaukee, WI 53209) solution containing 10^8 conidia/ml. In the chitin treatment, chitin was added to the 'Pelgel'-conidial suspension to a concentration of 3% (w/v). For the in-row treatments, *Trichoderma* was grown for 2 weeks on moist wheat bran. The inoculum was air-dried and then pulverized with a mortar and pestle. Commercial cultivar 'Mono-Hy A1 was used throughout.

Table 1 presents the results of stand counts expressed as a mean percentage of the nontreated control. Analyses of stand count data indicated that

Table 1. Mean stand counts as a % of nontreated control stands in a 1981 test to determine the effect of various treatments with *Trichoderma harzianum* on survival of field-grown sugarbeet planted in *Rhizoctonia*-infested soil

Treatment	% nontreated check on indicated date				
	6/2[1,2]	6/11	7/8	8/7	9/9
Trichoderma seed treatment	116 a	97	97	95	111
Trichoderma + chitin seed treatment	111 a	96	98	105	102
Trichoderma in-row	79 b	95	95	103	105
Trichoderma + EDTA in-row	77 b	95	98	113	98
Maneb seed treatment	107 a	97	105	120	118
(F-test for treatments)	*	NS	NS	NS	NS

[1]Stand counts made before beets were thinned to about 15 plants/row. All other counts were made after thinning. Values are means of four replications.

[2]Stand counts in the in-row treatments were not significantly different from control stands on June 2; however, this may be an artifact caused by wet soil and rototiller compaction at the time the treatments were applied to the plots.

differences among treatments were significant only at the first count (June 6), before thinning. At this time, stands in which *Trichoderma* or maneb were used as seed treatments were significantly better than the control. Stands

in the in-row treatments with *Trichoderma* were not significantly different from the control; however, this may be an artifact caused by wet soil and rototiller compaction at the time the treatments were applied to the plots.

Root rot severity at harvest as measured by disease index (DI) on an increasing severity scale of 0 to 7, and by percentage harvestable roots (disease classes 0 through 3) indicated no significant differences among treatments (Table 2).

Table 2. Effect of various treatments with *Trichoderma hamatum* on disease index and % harvestable roots of Mono-Hy A1 field-grown sugarbeet planted in *Rhizoctonia*-infested soil[1]

Treatment	Disease index[2]	% harvestable[3]
Trichoderma seed treatment	3.8	46.4
Trichoderma + chitin seed treatment	3.9	46.9
Trichoderma in-row	3.4	55.4
Trichoderma + EDTA in-row	3.9	46.2
Maneb seed treatment	3.2	56.0
Nontreated control	4.4	34.1
F-test	NS	NS

[1]Means of four replications.

[2]Disease index on a scale of 0 to 7, with 0 = no rot and 7 = dead.

[3]Disease index classes 0 through 3 were combined to calculate % harvestable beets.

Since there were four common treatments in our 1980 and 1981 field tests, individual analyses were performed on the data from these treatments for each year. An F-test of the error variances for both years indicated that the variances were homogeneous for both DI and % harvestable roots. Thus, combined analyses of variance were performed across years. In the combined analyses for both variables, differences between years and among treatments were highly significant; however, there was no significant year x treatment interaction in either analysis.

Table 3 presents the mean DIs and % harvestable roots for the combined means from both years. Only the in-row treatment with *Trichoderma* and the maneb fungicide seed treatment caused a significant reduction in DI and a significant increase in % harvestable roots as compared with the control. These treatments were not significantly different from each other. Although these treatments were significantly better than the control, it should be noted that 36-40% mean root loss was incurred in these plots.

Table 3. Means for disease index and % harvestable roots for a combined analysis of common treatments in two tests on the effect of *Trichoderma harzianum* on rhizoctonia root rot in Mono-Hy A1 field-grown sugarbeet planted in *Rhizoctonia*-infested soil[1]

Treatment	Disease index[2]	% harvestable[3]
Trichoderma seed treatment	3.4 ab	51.8 abc
Trichoderma + chitin seed treatment	3.6 ab	50.0 bc
Trichoderma in-row	3.1 bc	60.5 ab
Maneb seed treatment	2.6 c	64.1 a
Nontreated control	3.9 a	42.3 c

[1]Means of eight replications; means followed by the same letter are not significantly different at $P = 0.05$ according to Duncan's multiple range test.

[2,3]See footnotes for Table 2.

Effect of Three Herbicides Applied Postemergence on Severity of Rhizoctonia Root Rot.--E. G. Ruppel, R. J. Hecker, and E. E. Schweizer.

A randomized complete block design with three replications was used to test the effect of trifluralin (0.6 kg a.i./ha), EPTC (3.4 kg a.i./ha), and metolachlor (2.2 kg a.i./ha) on severity of rhizoctonia root rot in cultivars FC 703 (resistant), HH 32 (intermediate resistance), and Mono-Hy D2 (susceptible). The herbicides were applied broadcast and incorporated 1 week post-thinning. Plots were 4-rows wide and 6 m long with 56 cm between rows; only the center two rows were evaluated for root rot. Sugarbeets were sown in early April and harvested in early September. The experimental site was heavily infested with *Rhizoctonia solani* and, in addition, 56 kg/ha of dry, ground barley-grain inoculum was broadcast and incorporated before planting.

An analysis of variance of both disease index and % harvestable data indicated there were no significant differences among treatments (Table 1);

Table 1. Means for disease index (DI) and % harvestable (% H) roots in a test on the effect of three herbicides applied postemergence on rhizoctonia root rot in three field-grown sugarbeet cultivars[1]

Herbicide (kg a.i./ha)	Cultivar[2]					
	FC 703		HH 32		Mono-Hy D2	
	DI	% H	DI	% H	DI	% H
Trifluralin (0.6)	2.7	72.1	2.9	64.2	3.8	51.1
EPTC (3.4)	2.2	80.6	3.4	57.2	3.2	63.8
Metolachlor (2.2)	2.2	81.3	4.5	34.4	3.3	59.6
No herbicide	1.9	82.6	4.1	47.2	4.4	42.4

[1]DI based on a scale of 0 to 7, with 0 = no disease and 7 = plant dead; % H calculated by combining DI classes 0 through 3. Means of three replications; means within columns were not significantly different at $P = 0.05$.

[2]FC 703 = resistant; Mono-Hy D2 = susceptible; HH 32 = intermediate resistance.

there also was no significant cultivar x herbicide interaction. Thus, the herbicides used in this study had no significant adverse or beneficial effect on rhizoctonia root rot.

(This study was partially supported by the Grower-G.W. Joint Research Committee, Inc.)

Failure of Sulfur to Control Rhizoctonia Root Rot in the Field.--E. G. Ruppel and R. J. Hecker.

In a 1980 field experiment, flowable sulfurs at 5 gal/acre (34 kg S/ha) reduced root rot severity in field-grown sugarbeets (Sugarbeet Research, 1980 Report, pp. C15-C19). In 1981, we tested one of the flowables at 2, 3, and 8 liters product/ha (7, 13, and 34 kg S/ha) applied broadcast or in a 10-cm band over the row 1 week before planting; all treatments were incorporated 10 cm deep. Plots without sulfur served as controls. A randomized complete block design was used with three replications. Cultivars in the test included Mono-Hy D2 and HH 32. The experimental site was heavily infested with *Rhizoctonia solani*. In addition, 56 kg/ha of ground, barley-grain inoculum was broadcast and incorporated before sulfur application.

Contrary to 1980 results, sulfur had no significant effect on root rot severity regardless of cultivar, method of application, or dosage applied (Table 1). Treatment means across cultivars also were not significantly different.

Table 1. Effect of flowable sulfur at three rates and two methods of application on severity of rhizoctonia root rot in two field-grown sugarbeet cultivars[1]

Application[2]	Sulfur (kg/ha)	Disease index[3]			% harvestable[4]		
		D2[5]	HH32[5]	$\bar{x}$	D2	HH32	$\bar{x}$
---	0	4.6	3.7	4.2	33.4	50.5	42.0
Broadcast	7	5.6	3.4	4.5	13.0	53.1	33.1
	13	5.2	3.4	4.3	21.2	58.8	40.0
	34	5.9	2.7	4.3	13.9	69.0	41.5
Banded	7	5.0	4.3	4.7	24.6	41.6	33.1
	13	5.5	3.6	4.6	15.5	54.1	34.8
	34	4.7	3.6	4.2	30.8	56.6	43.7

[1]Means of three replications; means within columns not significantly different from each other at $P = 0.05$.

[2]Applications made preplant with 10-cm incorporation. For the banded application, the aqueous fungicide suspension was applied on a 10-cm band over the row.

[3]Disease index on a scale of 0 to 7, with 0 = no rot and 7 = plant dead.

[4]% harvestable calculated by combining disease index classes 0 through 3.

[5]D2 = susceptible commercial hybrid Mono-Hy D2; HH32 = commercial hybrid with intermediate resistance to *Rhizoctonia*.

(This study was partially supported by the Grower-G.W. Joint Research Committee, Inc.)

Response of Lines Resistant to Root-Rotting Strains (AG-2) of *Rhizoctonia solani* Inoculated with AG-4 Foliar-Blighting Strains.--E. G. Ruppel

Three root rot-resistant lines (FC 701/5, FC 702/5, FC 703), an intermediately resistant hybrid [(642027s1 CMS x 66219s1) x FC 703], and a highly susceptible check (FC 901) were inoculated with foliar isolates R-5, R-6, and R-7 of *Rhizoctonia solani*. Mycelial suspensions prepared from 7-day-old broth cultures were atomized onto the foliage of the plants, which then were held in a humidity chamber at 100% relative humidity for 96 hrs. Lesions developed on the foliage within 72 hr, and disease severity was evaluated at 96 hrs after inoculation. A factorial design was used with four replications in each of two trials. Results of both trials shows that there were no significant differences in disease reaction among the lines; there also was no significant line x isolate interaction in either test. At least in these tests, resistance to root isolates was not effective against foliar-blight strains of the fungus.

Yield Test of Best Experimental Hybrids Involving Rhizoctonia Resistant Pollinators.--R. J. Hecker and G. A. Smith.

In the program of breeding and development of rhizoctonia resistant germplasms we use the most promising multigerm resistant lines as pollinators on a set of male sterile testors. This is a means of getting some assessment of the combining ability of pollinators. In this general combining ability test of about 100 experimental hybrids each year we identify those hybrids which display relatively good specific combining ability for sucrose production. We then include these better hybrids in a yield test in the succeeding year. These disease free tests are grown at the CSU Agronomy Farm. Table 1 shows the results from this advanced testing of those better hybrids detected in 1979 and 1980. The first five hybrids have had two years of advance testing. The succeeding eight hybrids have been in the advance test for one year. Most of these experimental hybrids are not significantly different from Mono Hy D2 for recoverable sucrose production. Their disease indicies show that they have modest levels of resistance to rhizoctonia and are similar to HH 32. Thence, under disease free conditions some of these experimental hybrids would be expected to produce the equivalent to Mono Hy D2 but under disease conditions should be more productive than Mono Hy D2 due to the modest levels of rhizoctonia resistance which they exhibit. Since the male steriles involved in these hybrids are undoubtedly not among the best available in the industry it is likely that various of these rhizoctonia resistant pollinators would combine quite well with proven male steriles to produce partially resistant hybrids which might consistently out-perform Mono Hy D2 under disease free conditions and out-perform all susceptible hybrids in those fields with significant amounts of rhizoctonia infestation. All of the pollinators in Table 1 have been previously released to BSDF members except FC 702/5, FC 707/1, and FC 702/7. These should be released this coming year. Any BSDF members interested in further testing of any of these specific hybrids are welcome to the remnant seed that we may have of each.

Table 1. Disease-free performance of experimental hybrids using rhizoctonia susceptible females and resistant pollinators (Exp. 2, 80 & 2, 81), and disease (DI) from inoculated tests (Exp. 5R, 80 and 6R, 81).

Hybrid or Check	DI			Recov. suc.(T/A)			Root yield (T/A)			Sucrose (%)		
	80	81	X̄	80	81	X̄	80	81	X̄	80	81	X̄
(562CMSX546) X FC705	4.0			2.86	3.63	3.25	29.2	28.8	29.0	12.2	15.6	13.9
(SLC129CMSXSLC133) X FC702/5	4.7			3.03	3.55	3.29	24.9	26.4	25.7	15.0	16.6	15.8
(652016slCMSX662119s1) X FC705	3.9			3.14	3.42	3.28	30.1	28.1	29.1	12.9	15.2	14.1
(652016slCMSX662119s1) X FC707/1	4.6			3.04	3.33	3.19	29.0	27.2	28.1	13.0	15.2	14.1
(562CMSX546) X FC702/6	4.1			2.85	3.46	3.16	25.8	24.7	25.3	13.7	17.2	15.5
(SLC129CMSXEL44) X FC703/4	4.6				3.46			26.1			16.4	
(SLC129CMSXSP73747-0) X FC705		4.0			3.07			25.2			15.1	
(652016slCMSX662119s1) X FC702/7		4.8			3.07			22.4			16.8	
(SLC129CMSXEL44) X FC702/7		4.2			3.08			23.2			16.4	
(SLC129CMSXFrench mm TO) X FC703/4		4.4			3.62			27.0			16.6	
(FC604CMSXPolish mm TO) X FC702/7		4.2			3.27			24.2			16.7	
(FC604CMSXPolish mm TO) X FC703/4		4.2			2.89			23.3			15.4	
(SLC129CMSXSLC133) X FC702/7		4.4			3.05			24.4			15.5	
HH 32 (resist, hybrid)	4.3	4.8	4.5	3.07	3.47	3.27	27.3	26.1	26.7	13.9	16.4	15.2
Mono Hy D2 (yield check)	5.1	5.3	5.2	2.99	3.32	3.15	27.2	25.6	26.4	13.6	16.0	14.8
FC 703 (resistant check)	2.8	2.6	2.7									
LSD(.05)	0.6	0.8		0.32	0.27		3.2	2.0		0.8	0.5	

General and Specific Combining Ability Tests for Sucrose Yield of Rhizoctonia Resistant Experimental Hybrids.--R. J. Hecker and G. A. Smith.

The hybrids in this combining ability test were grown disease-free at the CSU Agronomy Research Center using single row plots in a triple lattice design with six replications. A set of 10 susceptible monogerm male sterile females was crossed with eight rhizoctonia resistant pollinators. The performance of the best individual hybrids is shown in Table 1. These 20 hybrids were all equal to the check (Mono Hy D2) for recoverable sucrose. These 20 hybrids are cases of relatively good specific combining ability. Limited quantities of remnant seed of these specific hybrids are available to those who might be interested in testing them in rhizoctonia problem areas.

The average performance of the eight pollinators across the set of male steriles is shown in Table 2. This gives some indication of the general combining ability of these respective pollinators. The most promising pollinator appears to be FC 701/6. It has relatively high rhizoctonia resistance with a DI of 2.7. Other promising pollinators are the synthetic of Japanese lines with a DI of 3.2 and a rhizoctonia resistant line developed from a pool of USSR multigerms, having a DI of 4.0. This latter line has been selected for rhizoctonia resistance for only three generations and although the DI of 4.0 indicates a moderate level of resistance to rhizoctonia, its resistance at this time is not considered adequate to impart a significant level of resistance to hybrids involving susceptible male steriles. Some of the other rhizoctonia resistant pollinators in Table 2, although not having the high average disease-free performance with the set of male sterile testers, do have some good specific hybrid combinations as indicated in Table 1. Those pollinators in Table 2, which have not yet been released, will be released as soon as their level of resistance is considered adequate for them to be useful as potential pollinators to produce hybrids with significant resistance to rhizoctonia.

The most productive hybrids in Table I will be retested in 1982 for rhizoctonia resistance and for productivity under disease-free conditions.

Table 1. Superior experimental hybrids in the 1981 disease free combining ability test (Exp. 1, 81) of hybrids involving Rhizoctonia resistant pollinators.

Entry No.	Hybrid	Recov. sucrose (T/A)	Root yield (T/A)	Sucrose (%)	T.J. Purity (%)
885	(662119s1 CMSX562) X Syn. of Rh lines	3.94	30.21	16.59	89.06
882	[(FC 504 CMSXFC502/2)X662119s1] X Rh USSR MM	3.90	31.98	15.61	88.35
818	(562 CMS X 546) X Rh USSR MM	3.88	32.98	15.79	87.72
835	(662119s1 CMS X 562) X Rh USSR MM	3.84	31.76	16.01	87.94
884	FC 606 CMS X FC 706	3.79	27.90	16.92	89.45
851	[(FC504CMS X FC502/2) X 62119s1] X FC707	3.79	30.62	16.19	88.86
856	(FC506CMS X 562) X Rh USSE MM	3.73	33.10	15.32	87.35
804	(FC505CMS X 562) X FC701/6	3.71	31.79	15.36	88.19
890	(562CMS X 546) X FC701/6	3.71	31.01	15.39	88.49
848	(FC505CMS X 562) X FC703/3	3.70	31.29	15.45	88.41
862	(SLC129 CMS X SLC133) X FC701/6	3.68	28.56	16.41	89.53
866	(662119s1CMS X 562) X FC701/6	3.68	32.98	14.83	87.20
842	(562CMS X 546) X FC707	3.65	27.86	16.71	89.13
886	(FC506CMS X French TO) X Rh USSR MM	3.66	30.67	15.63	87.77
874	(Polish mm CMS X French TO) X FC701/6	3.63	30.25	16.01	87.69
853	(662119s1 CMS X 562) X FC 706	3.61	29.60	15.86	88.60
827	[(FC504 CMS X FC502/2) X 662119s1] X FC701/6	3.61	31.04	15.30	87.66
887	(662119s1 CMS X 562) X FC707	3.60	29.60	15.96	88.06
820	(FC506 CMS X 562) X FC703(4X)	3.59	28.30	16.33	89.30
825	(FC506 CMS X French TO) X FC703/3	3.58	27.71	16.45	89.31
	Mono Hy D2 (check)	3.57	28.73	16.14	88.68
	LSD (.05)	0.48	3.22	1.18	1.60

Table 2. Average pollinator performance on a set of male steriles; yield characters from a disease-free test (1,81), and disease index (DI) fron an inoculated test (5,81).

Resistant pollinator	Recov. sucrose	Root yield	Sucrose	T.J. purity	DI
	(T/A)	(T/A)	(%)	(%)	
Syn of Rh resist lines	3.34	27.70	15.8	88.1	2.8
FC 703/3	3.36	26.62	16.2	89.0	2.8
Syn of Jap. lines	3.28	29.57	14.7	87.4	3.2
FC 701/6	3.50	30.00	15.4	88.1	2.7
FC 706	3.25	26.66	15.8	88.4	2.8
FC 707	3.41	27.94	15.9	88.3	2.6
FC 703 (4x)	3.45	27.96	15.9	88.8	3.4
Rhiz resist from USSR MM's	3.63	30.52	15.7	87.9	4.0

CERCOSPORA/CURLY TOP RESISTANCE BREEDING AND RELATED RESEARCH

(BSDF Project 25)

Breeding for Resistance to Cercospora and Curly Top Virus. 1981.--G. A. Smith and E. G. Ruppel.

The cooperative efforts of Dr. Dave Mumford in the curly top evaluations is hereby acknowledged.

The leaf spot epidemic in our 1981 nursery provided excellent conditions for evaluation of breeding lines. The average resistant check rating in 1981 was 4.0 on August 31. This is compared to a rating of 3.0 for 1980. The mean leaf spot rating of the susceptible check was 7.5. The epiphytotic developed rapidly and severely and peaked on or about August 31. The curly top epidemic at Logan, Utah was considered moderately severe, with US 41 averaging 5.0 and US 33 averaging 6.0. Under the severity of our 1981 epidemic, a leaf spot rating of 4.0 would be considered very good.

The results from our breeding nursery tests for the 1981 leaf spot and curly top epidemics are presented in Table 1. Only selected entries from the cercospora breeding programs are tested at Logan. Twenty eight of the 140 entries equaled or exceeded the resistance of the leaf spot resistant check. Several of these entries also had high resistance to curly top. Entries 1487, 1488, and 1545 which have exhibited such good resistance at the diploid level are currently being tetraploidized. When these lines are released they should provide exceptionally good parental components for triploid synthesis. In a 3-way top cross hybrid, if used as the male top cross parent (monogerm pollinators have not traditionally been used in this manner), these lines could contribute 66% of the genes for resistance. This is compared to 50% contributed by the resistant parent in a 3-way top cross hybrid where a resistant diploid is used as the male parent or 25% when the resistant line is used in the single cross component of the 3-way top cross.

Table 1. Mean leaf spot and curly top ratings of some breeding lines and other entries tested at Ft. Collins, CO and Logan, UT, 1981.

Entry no.	Seed no.	Description	Leaf spot	Curly top
1416	791013H03	FC 502/3 CMS X FC 605 T.O., mm	3.8	4.5
1417	791013H04	662119s1 CMS X FC 605 T.O., mm	4.3	3.0
1418	791013H05	FC 603 CMS X FC 605 T.O., mm	4.3	3.0
1419	791013H06	642027s1 CMS X FC 605 T.O., mm	3.8	3.5
1420	791013H07	1861 CMS X FC 605 T.O., mm	5.0	2.5
1421	791013H08	(642027s1 CMS X 662119s1 T.O.)X FC 605 T.O., mm	4.0	2.5
1422	791013H09	632028s1 CMS X FC 605 T.O., mm	4.0	4.5
1423	791013H010	622112s1 CMS X FC 605 T.O., mm	4.8	3.5
1424	791015H02	FC 605 CMS X FC 502/2 T.O.	3.3	
1425	791015H03	FC 606 CMS X FC 502/2 T.O.	3.3	
1426	791015H04	(652016s1 CMS X FC 605) X FC 502/2 T.O.	4.3	
1427	791016H02	FC 605 CMS X FC 502/3 T.O.	3.8	4.5
1428	791016H03	FC 606 CMS X FC 502/3 T.O.	4.0	
1429	791016H04	(652016s1 CMS X 662119s1 T.O.)X FC 502/3 T.O.	4.0	
1430	791016H05	632028s1 CMS X FC 502/3 T.O.	4.8	
1431	791017H03	652016s1 CMS X 662119s1 T.O.	5.5	3.5
1432	791017H05	FC 606 CMS X 662119s1 T.O.	5.8	1.5
1433	791017H06	[FC(504 X 502/2)CMS X FC 605 T.O.]X 662119s1 T.O.	4.3	3.0
1434	791017H07	(652016s1 CMS X FC 605 T.O.)X 662119s1 T.O.	4.8	2.5
1435	791019H03	FC 605 CMS X 661153HO; 642027s1 = FC 603 T.O.	4.0	3.0
1436	791019H04	FC 502/2 CMS X 661153HO; 642027s1 = FC 603 T.O.	4.0	
1437	791019H05	FC 606 CMS X 661153HO; 642027s1 = FC 603 T.O.	3.8	3.5
1438	791019H06	(652016s1 CMS X FC 605) X 661153HO; 642027s1= FC 603 T.O.	3.5	
1439	791021H03	1861 CMS X FC 606 T.O.	5.3	1.5
1440	791021H04	632028s1 CMS X FC 606 T.O.	5.8	3.0
1441	791021H06	(1861 CMS X 12166) X FC 606 T.O.	5.5	3.0
1442	791022H07	(652016s1 CMS X FC 605)X 1861 T.O., mm	5.8	3.0
1443	791023H02	FC 606CMS X 632028s1; 651151HOA,B; 661151HOA	5.0	3.5
1444	791023H03	[FC(504X502/2)CMS X FC 605]X632028s1; 651151HOA, B; 661151HOA	4.5	
1445	791024H02	FC 502/2 CMS X 622027s1, 642010s1, T.O.	4.0	
1446	791024H03	FC 606 CMS X 622027s1, 642010s1, T.O.	5.0	
1447	791024H04	(652016s1 CMS X 662119s1 T.O.)X 622027s1, 642010s1, T.O.	4.8	
1448	791025H04	[FC(504X502/2)CMS X FC 605]X 622112s1, 642063 T.O.	4.3	3.0
1449	791026H02	FC 606 CMS X SP 550	3.0	
1450	791027H3	[FC(504X502/2) CMS X FC 605]X FC 903 MM	5.0	
1451	791027H4	(652016s1 CMS X FC 605) X FC 903 MM	5.0	
1452	791028H2	FC 606 CMS X FC 904 MM	4.5	
1453	791028H3	[FC(504X502/2 CMS X FC 605] X FC 904 MM	4.8	
1454	791053H12	FC 607 CMS X FC 705	5.0	
1455	791056H9	FC607 CMS X Syn of GH Rh sel from FC 703	3.5	
1456	791057H11	(652016s1 CMS X 662119s1)X EL 43	4.3	
1457	791059H02	EL 44 CMS X SP 73747-0 T.O.	6.0	

Table 1. Mean leaf spot and curly top ratings. . .--Continued

Entry no.	Seed no.	Description	Leaf spot	Curly top
1458	791064H7	FC607 CMS X Syn fr FC 701X (LSR-CTR,mm,T.O.) may seg aa and mm	4.5	
1459	791122H6	[FC(504X502/2)CMS X FC 605]X 5th cy low Amino N sel at high N fertility	4.0	
1460	761039H02	FC 605 CMS X [FC(504X502/2) X SP 6322-0]	4.0	
1461	761036H05	FC605 CMS X 731021HO,T.O.,mm,res.to C.T. from 701162HO	4.0	
1462	A81-93	FC607 X SP 6822-0	4.5	
1463	751102H05	FC 506 CMS X FC 605 T.O.	3.5	3.0
1464	771077	US 201	3.5	
1465	781061H4	[FC(504CMS X 502/2)X FC 605] X FC 703	4.5	
1466	791053H13	(652016sl CMS X 662119sl) X FC 705	5.3	
1467	781063H7	(652016sl CMS X 662119sl) X Aula Dei 13	5.5	
1468	781067H2	[FC(504CMS X 502/2) X FC 605]X M-line syn from FC 702/5	3.8	
1469	781063H8	[(652016sl CMS X 662119sl)X FC 506]X Aula Dei 13	5.0	
1470	781063H4	[FC(504 CMS X 502/2)X FC 605]X Aula Dei 13	4.5	
1471	781063H9	FC(504 CMS X 502/2) X Aula Dei 13	4.8	
1472	791027H2	FC 606 CMS X FC 903 MM	5.3	
1473	781063H5	FC(506 CMS X 605) X Aula Dei 13	5.0	
1474	A79-1	Spanish LS "tolerant" line, 4X	4.3	
1475	A79-2	Spanish LS "tolerant" line, 4X	4.3	
1476	A79-3	Spanish LS "tolerant" line, 4X	4.5	
1477	A79-4	Spanish LS "tolerant" line, 4X	4.5	
1478	A79-5	Spainsh LSR, 4X, Harvest for ♀ roots etc.	4.3	
1479	A80-104	Beta 1237	6.5	
1480	761069H	FC 701/4 (4X)	4.5	
1481	691246-00	FC 701/4	5.0	
1482	751075H	FC 703 (4X)	4.0	
1483	781084	FC 703	5.5	
1484	801055H	Pooled USSR MM lines	7.0	
1485	A74-23	Aula Dei 645 (4X) LSR	4.5	
1486	A80-12	HH33; LSR Holly hyb.	4.8	
1487	A79-68	FC 607 CMS	3.8	4.0
1488	A78-45	FC 606 CMS	4.3	4.0
1489	A78-1	GW Mono Hy D2	6.0	
1490	791118H4	(FC 604 CMS X Polish PI 372277) X GW 674 sel.	5.8	
1491	801058H4	FC(504CMS X 502/2)X 662119sl X FC 707	6.0	
1492	801058H7	FC(504 CMS X 502/2) X FC 707	4.5	
1493	801058H5	FC 607 CMS X FC 707	4.8	
1494	801056	FC 707/2; 1 cy root inoc.	5.0	
1495	801150H2	FC 606 CMS X HS1 21, J. origin	5.0	
1496	801151H2	FC 606 CMS X HS1 22-1, J. origin	4.5	
1497	801151H3	FC 607 CMS X HS1 22-1, J. origin	4.5	
1498	801154H2	FC 606 CMS X HS1 301, 4X	5.5	
1499	801154H3	FC 607 CMS X HS1 301, 4X	5.5	
1500	801155H2	FC 606 CMS X HS1 101, 4X	6.3	
1501	801155H3	FC 607 CMS X HS1 101, 4X	6.0	
1502	A81-62	Mono Hy E4	4.3	
1503	A81-75	Mono Hy A4	6.3	

Table 1. Mean leaf spot and curly top ratings. . .--Continued

Entry no.	Seed no.	Description	Leaf spot	Curly top
1504	A81-72	SS-X 713 DC; Spreckels	5.5	
1505	801093H02	FC 606 CMS X FC 608 T.O.	4.5	
1506	801093H03	1861 CMS X FC 608 T.O.	6.0	
1507	801093H04	642027s1 CMS X FC 608 T.O.	4.3	
1508	801093H05	FC 607 CMS X FC 608 T.O.	4.5	
1509	801093H06	721055 CMS X FC 608 T.O.	4.8	
1510	801093H07	FC(504 CMS X 502/2) X FC 608 T.O.	4.0	
1511	801094H0	SP 70756-0, BRR, T.O.	6.8	
1512	801094H02	761036 CMS X SP 70756-0, BRR, T.O.	6.3	
1513	801094H03	(642027s1 CMS X 662119s1, T.O.)X SP 70756-0, BRR, T.O.	5.0	
1514	801094H04	FC 607 CMS X SP 70756-0, BRR, T.O.	4.8	
1515	801094H05	[(652016s1 CMS X 662119s1)X FC 506]X SP 70756 -0 BRR, T.O.	5.0	
1516	801095H02	FC 608 CMS X FC 606 T.O., mm, LSR-CTR	4.8	3.0
1517	801095H03	1861 CMS X FC 606 T.O., mm, LSR-CTR	6.3	
1518	801095H04	FC(504 CMS X 502/2)X FC 606 T.O., mm, LSR-CTR	4.0	
1519	801096H0	761036H0, mm from 662110s1 LSR-CTR	5.0	
1520	801096H02	FC 608 CMS X 761036H0, mm from 662110s1, LSR-CTR	4.0	3.0
1521	801096H03	FC 606 CMS X 761036H0, mm from 662110s1, LSR-CTR	5.0	3.0
1522	801096H04	FC(504 CMS X 502/2) X 761036H0, mm from 662110s1, LSR-CTR	3.8	
1523	801096H06	(642027s1 CMS X 662119s1, TO.O.)X761036H0, mm from 662110s1, LSR-CTR	4.3	2.5
1524	801096H07	FC 605 CMS X 761036H0, mm from 662110s1, LSR-CTR	3.5	3.0
1525	801096H08	FC 506 CMS X 761036H0, mm from 662110s1, LSR-CTR	4.3	
1526	801097H0	1861 T.O., mm	9.0	
1527	801097H02	FC 608 CMS X 1861 T.O., mm	5.8	
1528	801097H03	FC 606 CMS X 1861 T.O., mm	6.3	
1529	801097H04	FC(504 CMS X 502/2)X 1861 T.O. mm	4.8	
1530	801097H05	761036 CMS X 1861 T.O., mm	6.5	
1531	801097H06	(642027s1 CMS X 662119s1, T.O.)X 1861 T.O., mm	6.0	
1532	801097H07	(652016s1 CMS X 662119s1, T.O.)X 1861 T.O., mm	5.5	
1533	801097H08	FC 504 CMS X 1861 T.O., mm	5.3	
1534	801101H0	721055H0, good CA for CTR	7.5	
1535	801101H01	721055 CMS	5.0	5.0
1536	801101H02	FC 608 CMS X 721055H0	5.8	5.0
1537	801101H03	FC 606 CMS X 721055H0	5.3	5.5
1538	801101H04	1861 CMS X 721055H0	8.0	5.5
1539	801101H05	FC 607 CMS X 721055H0	4.8	4.0
1540	801101H06	(642027s1 CMS X 662119s1,T.O.,mm)X721055H0	6.3	4.5
1541	801101H07	[(652016s1 CMS X 662119s1)X FC 506 T.O.] X 721055H0	6.0	4.0

Table 1. Mean leaf spot and curly top ratings. . .--Continued

Entry no.	Seed no.	Description	Leaf spot	Curly top
1542	801101H08	FC 506 CMS X 721055H0	5.5	5.5
1543	801101H09	(652016s1 CMS X662119s1 T.O.)X 721055H0	6.8	3.5
1544	801101H010	[FC(504 X 502/2)X662119s1]X 721055H0	5.5	4.0
1545	801123H0	FC 607 T.O.	3.8	
1546	801058H	FC 707	5.3	
1547	801033H0	FC 708	4.0	
1548	801033H01	FC 708 CMS	4.5	
1549	801047H0	T.O. from pooled USSR mm lines	6.8	
1550	801049H	Pooled Rh lines; 2 cy root inoc.	5.8	
1551	801059H	Subline of FC 701/5	4.5	
1552	801060H	PC of FC 703 and GH sels	5.5	
1553	801061H	FC 801 PC_2	5.8	
1554	801062H	Rh. sel from Afan. lines	6.8	
1555	801063H	Rh. syn. from Jap. lines	6.0	
1556	801065H	Syn. from FC 701 X (mm, T.O., LSR, CTR)	4.5	
	Checks			
1557	671201H08	FC(504 X 502/2)X SP 6322-0, LSR check	4.0	
1558	A63-5	SP 5822-0, ILSR check	4.8	
1559	731083	Synthetic check, LSS check	7.5	
	US 33	Logan curly top check		6.0
	US 41	Logan curly top check		5.0
	LSD @ .05		1.1	

[1]Leaf spot and curly top ratings based on 0-10 scale with 0 = no symptoms and 10 = dead for curly top or complete defoliation for leaf spot.

Leaf Spot Evaluations of Sugarbeet Lines Submitted by BSDF-Member Companies--
E. G. Ruppel and G. A. Smith

Separate randomized complete block designs with two replications were used to evaluate a total of 180 breeding lines submitted by American Crystal, Betaseed, Bush Johnson, Great Western, Hilleshog, and Holly sugar and seed companies for resistance to Cercospora beticola. An additional test with three replications was used to evaluate 26 lines submitted by the Grower-Great Western Joint Research Committee, Inc. Internal checks included leaf spot resistant FC(504 X 502/2) X SP6322-0, a highly susceptible synthetic, and SP5822-0 having intermediate resistance. Two-row plots were 4 m long with 56 cm between rows. The nursery was planted on April 27; inoculations were made July 6 and 14. The epiphytotic developed rapidly and severely, peaking about August 31. Leaf spot evaluations were made August 26 and 31. The mean rating of the susceptible check across all company tests was 8.0, whereas the resistant check was 4.1 on August 31. Company lines ranged from 2.8 to 8.5 on this date. Results of the individual tests were tabulated, statistically analyzed, and sent to each respective contributor.

Prediction of Three-Way Top Cross Sugarbeet Hybrid Performance.--G. N. Skaracis and G. A. Smith.

The objective of this study was: a) to develop and evaluate various models to predict the performance of three-way top crosses without producing and testing these crosses; and, b) based on quantitative genetic models, to assess the relative importance of different types of gene effects in controlling the expression of root yield, sucrose content, and juice purity in a fixed set of genotypes.

A fixed set of inbred and pollinator diploid sugarbeet lines was used to synthesize all possible inbred X inbred and inbred X pollinator single crosses. In addition, this material was used to produce all possible three-way top cross hybrids. The resulting crosses were grown in the field in the summers of 1980 and 1981 along with the parental lines. A supplementary group of parental lines and crosses also was included in the 1981 experiment.

Additive and dominance gene effects were the most important for root yield. Sucrose content and juice purity were controlled almost exclusively by additive gene effects. No significant epistatic effects were detected for any of the traits studied.

Results of prediction studies suggested the use of an inbred X pollinator factorial mating design as a means of predicting the important traits of three-way top cross hybrids. This approach would be compatible with sugarbeet breeding program procedures. It was concluded, therefore, that the inbred X pollinator crosses be grown in preliminary trials at several locations, and the performance of the three-way top cross hybrids be predicted from the results of the trials. Additive gene effects, estimated from the factorial design, will suffice to predict sucrose content and juice purity. Unless new inbred lines are to be tested with a selected (elite) group of pollinators, additive and nonadditive effects would be required for the prediction of root yield and gross sugar. A reduced number of selected three-way top crosses per se, then should be produced and evaluated over enough environments to provide for a final selection of the superior hybrids for commercial release.

SUGARBEET QUALITY IMPROVEMENT (BSDF Project 53)

Sodium, Potassium, and Amino N in Fodder Beet Lines.--S. S. Martin and G. A. Smith.

Very little has been known about the impurity components of fodder beets. We used the 1980 Uniform Fodder Beet Trial (see descriptions in the 1980 Report) as the source of samples for determination of sodium, potassium, and amino N. Fourteen fodder beet entries and two sugarbeet check varieties were grown at Ft. Collins in a randomized block design with six replications. Analyses were made on sucrose filtrates clarified by aluminum chloride (1.0 g/L). Sodium and potassium were determined by flame photometry with lithium internal standard, and amino N was determined spectrophotometrically after reaction with ninhydrin. Analytical results were expressed both as mg/100 ml clarified filtrate (Table 1) and as grams per 100 grams sucrose (Table 2).

Table 1. Sodium, potassium, and amino N contents of 14 fodder beet lines and 2 checks. Data are in mg/100 ml aluminum-clarified sucrose filtrate.

Entry	Description	% of fr wt Sucrose	- - mg/100 ml Al filtrate - - Sodium	Potassium	Amino N
951	Lamono I (2X)	12.54 cd	9.6 bc	24.6 bcd	2.77 bc
952	Lamono II (2X)	11.40 ef	12.9 ab	22.7 cd	2.77 bc
953	Monorosa	13.00 c	11.7 ab	27.0 abc	4.20 a
954	Yellow Daeno	10.05 gh	13.6 ab	27.2 abc	2.93 bc
955	Monoblanc (P)[1]	11.95 cde	13.5 ab	26.6 abcd	3.63 ab
956	Kyros (P)	11.13 ef	12.1 ab	23.7 bcd	2.20 c
957	Monara (P)	9.03 i	13.4 ab	31.4 d	2.82 bc
958	Monriac	11.67 def	10.5 abc	26.5 abcd	3.15 abc
959	Eckdobarres (P)	8.79 i	13.5 ab	26.0 abcd	2.78 bc
960	Oscar	9.62 hi	13.9 a	28.0 abc	2.80 bc
961	Beta Rose Sugar	10.85 fg	12.5 ab	29.1 ab	3.22 abc
962	Barsien (78-2)	12.65 cd	11.2 abc	24.6 bcd	2.82 bc
963	Monovigor	11.35 ef	13.4 ab	27.7 abc	3.80 ab
964	Monorosover	11.79 def	11.6 ab	29.2 ab	3.83 ab
966	Zwanpoly	15.92 b	7.8 c	25.2 bcd	2.98 abc
965	GW Mono Hy D2	17.59 a	3.0 d	21.5 d	3.60 ab
F-test		55.2**	5.78**	2.39**	2.13*

[1](P) = Pelleted
Within columns, means not followed by the same letter are significantly different by Duncan's multiple range test (0.05 level).

Not unexpectedly, analyses of variance indicated significant differences among entries for sucrose and for the three chemical components, whether expressed volumetrically or per unit sucrose. Duncan's multiple range test results are shown semi-graphically for more ready examination of comparisons (Tables 1 and 2).

Sucrose percentage in the fodder beet lines was significantly lower than in either of the checks, Mono Hy D2 or Zwanpoly (Table 1). With data

expressed volumetrically, both Zwanpoly and all the fodder beet entries were significantly higher in sodium content than D2, but only about half the fodder beets differed from the checks in potassium and amino N content.

When data were expressed as g/100 sucrose (Table 2), again all the fodder beet lines differed significantly from the two checks in sodium content; in fact, the fodder beet line with lowest sodium (Lamono I, entry 951) relative to sucrose still had almost five times the value for Mono Hy D2. Potassium in the fodder beet lines was significantly greater than that of the two checks, ranging from 150 to 290% of the value in D2. Amino N contents per unit sucrose did not show much differentiation between fodder beets and checks, with only one entry (Monovigor, entry 963) differing significantly from Mono Hy D2.

Table 2. Sodium, potassium, and amino N contents of 14 fodder beet lines and 2 sugarbeet checks, data expressed in g/100 g sucrose.

		- - - - g/100 g sucrose - - - - - - - -		
Entry	Description	Sodium	Potassium	Amino N
951	Lamono I (2X)	0.60 cd	1.51 de	0.17 abcd
952	Lamono II (2X)	0.88 abc	1.53 de	0.19 abcd
953	Monorosa	0.70 bc	1.61 de	0.25 ab
954	Yellow Daeno	1.04 ab	2.08 bc	0.22 abcd
955	Monoblanc (P)[1]	0.87 abc	1.71 cd	0.23 abcd
956	Kyros (P)	0.85 abc	1.64 cde	0.15 cd
957	Monara (P)	1.16 a	2.70 a	0.24 abc
958	Monriac	0.71 bc	1.75 cd	0.21 abcd
959	Eckdobarres (P)	1.20 a	2.29 ab	0.25 abc
960	Oscar	1.13 a	2.25 b	0.23 abcd
961	Beta Rose Sugar	0.90 abc	2.09 bc	0.23 abcd
962	Barsien (78-2)	0.68 cd	1.49 de	0.17 abcd
963	Monovigor	0.93 abc	1.89 bcd	0.26 a
964	Monorosover	0.76 bc	1.90 bcd	0.25 abc
966	Zwanpoly	0.38 de	1.23 ef	0.15 d
965	GW Mono Hy D2	0.13 e	0.94 f	0.16 bcd
F-test		7.79**	10.93**	1.99*

[1](P) = Pelleted

Within columns, means not followed by the same letter are significantly different by Duncan's multiple range test (0.05 level).

The Effect of Benomyl on Some Chemical Constituents of Sugarbeet.--G. A. Smith, S. S. Martin and G. N. Skaracis.

In 1978 we reported that with increasing severity of *C. beticola* infection there was a general increase in nonsucrose chemical components, and a decrease in gross sucrose yield, yield components, and purity (see Crop Sci. 18:39-42, 1978). In that study, data from disease controlled plots of each entry were compared to data from plots in which disease was not controlled. Both sets of plots were artificially inoculated with *Cercospora beticola*. In the non-disease plots, control was achieved by bi-weekly sprays of benomyl. We considered the possible effect of benomyl per se on the nonsucrose chemical components, but a review of the literature at that time yielded no suggestion that benomyl affects yield or chemical component concentration in sugarbeets.

We designed the present experiment to determine if benomyl does in fact affect the components of juice purity under non-disease conditions. Eight cultivars known to range from leaf spot resistant to leaf spot susceptible were grown in both 1980 and 1981 in a randomized block design with four replications. Plots consisted of two 23 foot long rows spaced 22 inches apart and bordered on each side by two rows of medium vigor redleaf sugarbeet. These border rows equalized competition and provided a buffer zone for plots receiving fungicidal spray. Each cultivar occurred twice in each block: one plot received fungicidal spray and one plot was not sprayed. To the benomyl sprayed plots, solutions of 6.8 g benomyl wettable powder (50% a.i.) in 15.1 liters of water were applied at 585 cc/ha. Treated plots were sprayed six times at 14-day intervals beginning on June 25 each year. Plots were harvested at the normal time each year and data obtained for yield, sucrose, purity and for the chemical juice constituents chloride, sodium, potassium, amino N, total N and betaine.

Results of this two year study show significant reductions in amino N, total N and betaine following the benomyl spray regimes used (Table 1). These results were consistent within years and on the combined data from the two years. All of the non-sucrose chemical characters measured were reduced by the benomyl treatment, although not always significantly so. Root weight, sucrose and purity also were increased by the benomyl treatment in both years of the study. However, these increases were only significant for root weight in 1981 and for purity % in 1980.

To our knowledge, this is the first report of significant quality component changes due to benomyl.

Table 1. Summary of means of 8 cultivars with and without benomyl treatment grown under *Cercospora*-free conditions. (Root weight is in tons/acre and chemical components are in mg/100 ml raw juice.)

	1980			1981		
Character	Treated		Untreated	Treated		Untreated
Root wt.	24.8		23.8	23.1	**	21.2
Sucrose %	14.0		13.8	16.0		15.8
Purity %	85.8	*	84.9	91.7		91.4
Chloride	16.9		18.9	10.5		10.6
Sodium	82.3		88.4	25.7	**	29.7
Potassium	178.1		180.5	132.2		136.1
Amino N	63.5	**	73.2	26.4	**	33.9
Total N	198.8	**	217.0	127.9	**	137.1
Betaine	348.2	**	364.6	286.5	*	302.0

*, ** Indicates significant difference between treated and untreated means at the .05 and .01 probability levels, respectively.

EXTRACT CLARIFICATION RESEARCH (BSDF Project 81)

Sugarbeet Extract Clarification.-- S. S. Martin.

Aluminum salts have largely supplanted lead compounds for clarification of sugarbeet extracts for polarimetric sucrose determination. However, the aluminum clarified extracts sometimes are more colored than those prepared with lead clarification, and aluminum does not adequately clarify some more highly colored, complex factory juices. Therefore, a search is being undertaken for still other clarification procedures. As a preliminary step, a literature review of the sources and nature of colored impurities or potential color-producing reactions in sugarbeet extracts has been made, and a brief summary and some selected references are presented here. This review concentrates only on clarification of laboratory extracts for polarimetric analysis.

Clarification of aqueous sugarbeet brei extracts must include both removal of macroscopic and colloidal debris and prevention of formation or removal of colored compounds. Removal of cellular debris is most simply a filtration step, with or without a filter aid. Methods such as centrifugation would also serve the purpose, but are not as readily employed on numerous samples or in semi-automated or automated procedures.

Some preformed colored compounds, particularly the betalain pigments or their precursors, may be present in sugarbeet extracts, but the majority of clarification difficulties are related to colored materials arising after sucrose extraction. Both enzymatic and non-enzymatic reactions are involved, and many physical and chemical factors influence the final products formed and their amounts. Perhaps the most important source of rapid color formation is the phenolic amino acid tyrosine (3-hydroxyphenylalanine). Tyrosine is hydroxylated by the enzyme o-diphenol:O_2 oxidoreductase (E.C. 1.10.3.1), more simply called phenol oxidase or polyphenol oxidase. The product, 3,4-dihydroxyphenylalanine, is abbreviated "DOPA". Enzymes with this activity are called cresolases, whereas those capable of oxidizing o-dihydroxyphenols such as DOPA to the corresponding o-quinone are catecholases. Sugarbeet phenol oxidase has been characterized as an enzyme of molecular weight about 200,000, with both cresolase and catecholase activity. There is controversy as to whether DOPA is present in the sugarbeet root before the tissue is disrupted by slicing or sawing for brei, but it appears likely that it is present in very small amounts, if at all. Tyrosine is an important sugarbeet amino acid, and the ease with which it is enzymatically oxidized to DOPA can lead to the impression that DOPA was present initially.

DOPA can further oxidize by non-enzymatic means in air to dark-colored melanins; DOPA also is enzymatically oxidized by polyphenol oxidase to DOPA-quinone, which then polymerizes and undergoes other oxidative steps with the ultimate formation of melanins. The degree of polymerization and thus the molecular weights of the products is time dependent. Approaches to preventing protein-quinone condensations to melanins might include preventing formation of the quinone (such as by inhibiting the copper-containing phenol oxidase by use of copper complexing agents) or employing quinone-scavenging reagents to react with quinones immediately upon their formation.

In addition to tyrosine, other amino acids and amides, monosaccharides, and other phenols in sugarbeet extracts are potential precursors of colored compounds formed rapidly in an air atmosphere. Solution pH is an important factor in color development, as is the use of heat in sample preparation. Complexes of phenols with heavy metals can lead to colored compounds, as can Maillard reactions between amino acids and carbonyl compounds. The importance of these reactions undoubtedly depends on the nature of the beet material being analyzed, and in particular on the inclusion or exclusion of crown and leaf tissues which are high in such impurities in comparison to the storage root.

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RESEARCH NOT FUNDED BY BSDF BUT OF INTEREST TO BSDF MEMBERS

International Cooperative Cercospora Resistance Test.--G. A. Smith and Bengt-Olle Jonsson

In 1980 and again in 1981, arrangements were made to test several Ft. Collins developed cercospora resistant breeding lines with several European developed breeding lines under natural epidemic conditions in southern Europe. The objective of this research is to detect the occurrence of European and American strains of Cercospora beticola differing in pathogenecity. All of the cercospora resistant lines released from the Ft. Collins breeding programs are developed under artificially induced field epidemics.

Of particular interest was the evaluation of several of the newest resistant released and unreleased breeding lines from the Ft. Collins breeding program.

Replicated field tests consisting of 5 entries from Ft. Collins and 7 entries submitted by the Hilleshog company were conducted under natural field epidemics in Greece (Platy-Imathios), Stelata, Italy (Po Valley), and Spain (Duero River Valley). As in 1980, the same entries were tested under our standard artificial field inoculation at Ft. Collins. Epidemics in 1981 were severe in Italy, moderate in Greece and mild and late in Spain. The epidemic at Ft. Collins was very severe as compared to previous years. An old multigerm Italian variety "Alba" was used as the resistant check at all locations. This variety, although very leaf spot resistant, is not grown commercially and is strictly a disease check. FC LRC is the long term cercospora resistant check at Ft. Collins and was included in the tests at all locations.

A summary of the 1981 results are presented in Table 1. Results from Spain had not arrived in time for inclusion in this report.

FC607CMS and the new experimental line FCL 3 displayed consistently high leaf spot resistance in all countries. Results were very similar in 1980 tests (see Smith and Jonsson, p C29-C30, 1980 Blue Book). Based on two full years of testing, we have not seen any evidence of strain differences for pathogenecity. The test will be repeated in the same countries plus an additional test in France in 1982.

Table 1. Summary of leaf spot ratings from international cooperative cercospora resistance evaluation tests.

Entry	U.S.	Greece	Italy	Across $\bar{x}$ countries
CR-1	5.3	3.7	5.5	4.8[1/]
CR-3	6.6	4.9	7.3	6.2
CR-6	8.1	6.3	7.5	7.3
Alba	4.0	2.5	3.3	3.3
CR-13	6.5	4.3	6.5	5.5
CR-14	5.1	3.4	5.3	4.6
CR-15	4.4	2.8	4.5	3.9
FC LRC, FC(504x502/2)X SP6322-0	4.3	1.0	3.5	2.9
FCL 3, FC605 CMS x 731021	4.3	0.8	3.3	2.8
FCL 1, FC 607 CMS	3.6	1.6	3.8	3.0
FCL 2, FC 606 CMS	4.9	2.4	5.5	4.3
FC ILC, SP 5822-0	5.0	3.0	5.5	4.5

[1/] Leaf spot ratings based on 0-10 scale with 0 = no symptoms and 10 = complete defoliation. Tests within each country were conducted on randomized blocks with 4 replications. Readings were taken at the peak of the cercospora epidemic.

The Evaluation of Fodder Beet as a Source of Ethanol.--G. A. Smith

In 1980, we began an evaluation of fodder beet as one of several potential feed stocks for ethanol (ETOH) production. This project, made possible by short-term funding, is designed to establish the agronomic yield capabilities of candidate crops as they relate to potential biomass or ethanol production.

Uniform variety tests were conducted at Ft. Collins, at five additional locations in 1980, and at six additional locations in 1981. Results for the 1980 tests were presented in the 1980 "Blue Book". Results for 1981 are presented in Table 1. All of the entries except the known checks were developed in Europe. The high dry matter and sucrose percentages indicate that most are sugarbeet X fodder beet hybrids with a considerable amount of sugarbeet germplasm.

Theoretical ethanol yield ranged from 559 to 693 gallons per acre. Entry 962, which gave the highest theoretical yield, also produced over 43 tons of roots per acre. This high root yield and high ethanol production potential is a characteristic pattern for fodder beet and for fodder beet X sugarbeet hybrids. When the efficiency of production for ethanol is considered, these high tonnage varieties are not likely the best choice for ethanol production. If we examine the ratio of tons per acre and gallons of ETOH per acre we can see which entries are the most efficient producers. For example, the lowest yielding sugarbeet check (entry 974) produced 23.8 tons per acre and 566 gallons of ETOH per acre. This is 23.7 gallons per ton as compared to only 15.9 gallons per ton for the highest yielding entry 962. A "fuel type beet" must be one that produces the maximum per unit area of land but with a minimum of excess tonnage. The second highest ETOH yielding entry was a low quality sugarbeet, 'Zwaan Poly'. When this entry is compared to the highest yielding entry 962 an interesting pattern can be seen. To produce 693 gallons of ETOH per acre, which is about the same as the 688 gallons of entry 972, entry 962 produced 43.5 tons of roots as compared to 33.4 tons for entry 972. Thus, the production of essentially the same amount of ETOH per acre by entry 962 required 23% more tonnage. Three of the four sugarbeet checks showed a potential production of over 23 gallons of ETOH per ton of beets. This is compared to the highest yielding fodder types which gave a theoretical ETOH yield of about 16 gallons per ton.

It is obvious from these results and from similar past studies that theoretical alcohol production is more than a function of tonnage and gross sugar. When the economics are considered, including the energy requirements for lifting and hauling potential fuel beets, it appears likely that regular sugarbeets may well be the most economical feedstocks for ethanol production. So-called lower quality sugar beets, that is those that have slightly lower purity than are preferred for crystalline sugar production, appear to be by far the best candidates for ethanol production. We have tested such sugarbeet varieties against the better performing fodder beet X sugarbeet hybrids. The results of those tests are presented in another report in this book (see Martin, Smith and Shoener).

Table 1. Summary of means for fodder beet and sugarbeet X fodder beet hybrids and four sugarbeet checks.

Entry	Description	% Sugar	Root yield T/A	Gross lbs sugar	Theoretical gal ETOH
959	Lamono I, (2X) Sweden	10.8	39.4	8529	609
960	Lamono II, (2X) Sweden	9.4	44.2	8348	569
961	Kyros (3X), Denmark	9.6	42.6	8196	585
962	Monovigor (3X), France	11.2	43.5	9711	693
963	Barsein (3X), Netherlands	10.8	36.5	7904	564
964	Monriac (3X), France	9.7	43.2	8425	601
965	Monorosa (2X), Netherlands	11.6	34.1	7947	567
966	Hugin (3X), Denmark	10.2	38.3	7828	559
967	Monovert (3X), Netherlands	9.9	39.8	7942	567
968	TC5/45-9 (3X), Netherlands	9.9	44.7	8867	633
969	Barb 79-1 (3X), Netherlands	10.3	39.1	8087	577
970	TC2018 (3X), Netherlands	11.7	37.7	8871	633
971	GW D2 US (2X), check	16.4	26.3	8631	616
972	Zwaan Poly, check	14.4	33.4	9634	688
973	Beta 1237, check	16.6	27.6	9142	653
974	G W Mono E4, check	16.6	23.8	7925	566

LSD @ .05 Level for gross sugar = 1060 lbs

Potential Ethanol Production Rankings for a Selected Group of Sugarbeet and Sugarbeet X Fodder Beet Hybrids.--S. S. Martin, G. A. Smith, and J. L. Shoener.

Initial evidence suggests that sugarbeet cultivars may equal or exceed fodder beet or fodder beet X sugarbeet hybrids for total sugar production per acre, and thus for potential ethanol production. Of equal importance is the economic necessity to maximize sugar yield yet minimize the root yield that must be harvested and processed to obtain that sugar. We report here the results of study of the sucrose production potential of several fodder beets and of some experimental sugarbeet cultivars selected for their high sucrose production per unit area. The experiment was conducted as a randomized complete block with six replications and ten entries:

Entry	Description
921	GW Mono Hy D2
922	Zwanpoly
923	GW Mono Hy T6 (3X) [550 CMS X Zwanpoly]
924	GW Mono Hy T8 (3X) [D2 CMS X Zwanpoly]
925	14 V Gemi 22 (3X) [B8 M52 X B6 5T, Netherlands]
926	E Type (4X) [19% D.M., Poland]
927	Kyros (3X) [16% D.M., Mono, Denmark]
928	Holly HH14, Monogerm
929	Holly HH19, Monogerm
930	Holly HH25, Monogerm

Results for sucrose percentage, root yield, and potential ethanol yield (equivalent to gross sucrose yield) are summarized in Table 1. There were highly significant differences among cultivars for sucrose and for root yield. Duncan's multiple range test comparisons for these two factors are also shown in Table 1; for this set of cultivars, the frequently observed inverse relationship between sucrose percentage and root yield is almost perfectly displayed. Potential ethanol yields were not statistically different among cultivars, despite a difference of over 100 gallons per acre between the lowest and the highest means. Coefficients of variation ranged from 5.5% to 21.2%, and inspection of the data showed inconsistencies among plots that were not accounted for by replication. Presumably this occurred because of field inhomogeneities. As a result, we chose to examine the data by nonparametric ranking methods, treating each field plot separately. Each plot was ranked for potential ethanol production and for root yield; thus, plots were ranked from 1 (lowest) to 60 (highest) for each factor. To maximize ethanol potential while minimizing root tonnage, the most desirable combination of ranks for a plot would therefore be highest (60) for EtOH potential, and lowest (1) for root yield; plots with highest positive numbers for the rank difference ($Rank_{EtOH} - Rank_{Yield}$) approach this most closely. Ranks and rank differences were calculated in this way then the rank differences were summed over the six plots for each cultivar (Table 1). The adapted commercial variety, entry 921, ranked first overall for potential ethanol production, followed closely by entry 923, one of the experimental high gross sucrose hybrids. At the bottom, ranking 9th and 10th respectively, were fodder beet entries 926 and 927.

The results of the rank difference analysis are almost identical to those obtained by ranking the cultivars according to gallons potential ethanol per ton of beets. In the latter case entries 923 and 921 reverse places to become first and second ranked, respectively, and all other ranks remain unchanged.

Table 1. Sucrose, root yield, and potential ethanol yield for ten sugarbeet and sugarbeet X fodder beet cultivars.

Entry	Sucrose %	Yield T/acre	- Potential EtOH - gal/acre	gal/T	Sum of (Rank diff.)[1]	Overall Rank
921	16.42a	23.8e	557	23.4	+97	1
922	13.56bc	30.5bc	588	19.3	-51.5	8
923	16.42a	27.1cde	637	23.5	+92	2
924	14.04abc	30.0bc	596	19.9	-29.5	7
925	15.06abc	30.5bc	651	21.3	+44	5
926	12.58c	30.8b	548	18.0	-128	9
927	9.62d	44.4a	603	13.6	-159	10
928	15.32ab	26.9cde	586	21.8	+64	4
929	14.85abc	27.7bcd	584	21.1	+7	6
930	16.02a	25.4de	579	22.8	+84	3
F	8.10**	21.3**	1.18ns			

[1] Sum of (rank diffs.) = $\sum_{n=1}^{6}$ ($Rank_{EtOH} - Rank_{Yield}$) [see text].

Entry 925, the Netherlands triploid, resembled several of the experimental sugarbeet varieties in sucrose percentage and yield, and produced the highest absolute value of potential ethanol gallons per acre, but ranked only fifth in gallons per ton or summed rank differences for all plots.

Purity, sodium, potassium, and amino N contents also were determined for these cultivars. The data were obtained primarily for another study to be reported subsequently, but are presented here for examination in conjunction with the ethanol production rankings (Table 2).

Table 2. Purity and chemical components (grams per 100 g sucrose in raw juice) for ten cultivars of sugarbeets and sugarbeet X fodder beet hybrids.

Entry	% Purity	grams/100 g Sucrose Sodium	Potassium	Amino N
921	89.6 a[1]	0.31 bc	0.97 c	0.27
922	87.7 a	0.85 abc	1.19 abc	0.30
923	89.9 a	0.28 c	1.02 bc	0.24
924	87.8 a	0.61 abc	1.19 abc	0.32
925	89.9 a	0.44 bc	1.07 bc	0.23
926	87.0 a	0.87 ab	1.28 ab	0.27
927	83.1 b	1.11 a	2.15 a	0.26
928	88.1 a	0.52 bc	1.19 abc	0.28
929	88.0 a	0.54 abc	1.19 abc	0.28
930	89.3 a	0.36 bc	1.05 bc	0.26
F - test	3.83**	2.43*	16.4**	0.32 ns

[1] Means followed by the same letter are not significantly different at the 0.05 probability level by Duncan's multiple range test.

Only the fodder beet entry 927 differed from the others in purity. For sodium and potassium content, only the two fodder beet entries 926 and 927 differed significantly from the cultivar with lowest content, the experimental hybrid sugarbeet entry 923 and the commercial entry 921, respectively.

In summary, the data suggest that high gross sucrose producing sugarbeets, including some adapted commercial varieties already in widespread use, may be the cultivars of choice for potential ethanol production. A second field trial of this experiment is planned.

Sweet Sorghum Ethanol Yield Potential.--G. A. Smith

An evaluation of sweet sorghum (Sorghum bicolor) as a potential feed stock for ethanol production was begun in 1980 and continued in 1981 as part of a USDA energy study.

Sweet sorghum cultivars were evaluated for yield potential and theoretical ETOH production potential at seven locations in the continental U.S. and one location in Hawaii. Cooperators in this project were G. E. Coe, F. J. Hills, G. J. Hogaboam, D. L. Doney, P. H. Moore, D. Broadhead, I. O. Skoyen and R. T. Lewellan. Data collected included total biomass yield, total sugar, dry matter, height, stalk diameter, percent of leaves and stalks and types of sugar.

Summarized yield data and theoretical ETOH production are presented in Table 1. Test sites ranged form 21° N latitude to 43° N latitude and from 77° W longitude to 158° W longitude. This test, as in 1980, indicated that sweet sorghum has potentially very wide adaptability to varying environments. Average theoretical ETOH production for the northernmost location (East Lansing, Michigan) was 419 g/A with one entry having a potential of about 537 g/A. The Davis, California and Aiea, Hawaii locations had several entries with theoretical ETOH yields of over 800 g/A and as expected were the highest yielding locations. The obvious wide adaptability of sweet sorghum is accompanied by easy planting and cultivation, relatively few major disease problems and high fiber content (for potential use in paper production or as a combustible fuel source). The prominent disadvantage is storability of harvested stalks.

Table 1. Summary of Brix in degrees, net stalk yield (T/A) and theoretical ethanol yield (gal/A) from uniform variety tests conducted at eight locations in 1981.

Location	Dale	Keller	Rio	Wray	Mer 71-1	Mn 1500	$\bar{x}$
			Brix				
Beltsville	17.84	19.44	17.54	18.85	14.96	16.94	
Davis*	15.38	17.66	17.32	15.00	14.18	16.77	
East Lansing	16.05	18.21	18.06	14.55	14.84	16.70	
Farmington	12.50	16.20	15.43	12.05	11.38	15.10	
Fort Collins	10.83	15.10	15.05	9.93	10.40	15.83	
Hawaii	14.60	19.62	18.00	18.77	16.07	16.25	
Meridian	18.50	18.00	19.10	20.50	17.60	18.10	
Salinas	16.55	18.99	18.75	14.11	15.91	17.93	
			Net stalk yield				
Beltsville	31.14	28.81	27.30	32.27	37.09	29.32	
Davis	50.90	47.43	39.25	53.14	46.79	41.66	
East Lansing	24.15	27.52	16.60	29.02	23.52	23.16	
Farmington	28.49	23.85	21.77	30.79	25.34	23.41	
Fort Collins	36.86	37.57	32.48	39.70	38.42	30.56	
Hawaii	44.00	48.15	42.85	57.15	55.47	78.62	
Meridian	22.3	21.4	19.2	19.4	32.3	34.0	
Salinas	31.88	29.03	22.37	29.97	33.74	23.39	
			Potential ethanol				
Beltsville	595	600	513	652	594	532	581
Davis	839	897	728	854	711	749	796
East Lansing	415	537	321	452	374	414	419
Farmington	382	414	360	397	309	379	373
Fort Collins	428	608	524	422	428	518	488
Hawaii	688	1012	826	1149	955	1368	999
Meridian	442	413	393	426	609	659	490
Salinas	565	591	449	453	575	449	439

*Brix values for Davis are across location means for each entry.

Research to Develop a Trisomic Series in Homozygous Sugarbeet.--R. J. Hecker and I. Romagosa.

This project to develop a trisomic series in homozygous sugarbeets was approved and funded under the U.S./Spanish Program for Scientific and Technological Cooperation. We have at this point isolated and tentatively identified eight of the nine possible trisomic types in one homozygous sugarbeet line. We anticipate having all nine types isolated and identified within one year. Seed multiplications of these trisomic types will then require one to two years. Seed of these trisomic types then will be made available to scientists throughout the world. We anticipate that these trisomics should be a very useful tool to help sugarbeet scientists ultimately establish the nine linkage groups in sugarbeet, assign genes to their correct linkage groups, and determine linkage relationships among genes now known or yet to be discovered. We are also hopeful that within the project we will be able to develop the trisomic series in an annual genotype which would facilitate its utilization.

Preliminary Yield Test of Experimental Hybrids for Potential Use in the U.S. and Spain.--R. J. Hecker.

The U.S./Spanish Bilateral Treaty includes funds for cooperative research between the U.S. and Spain. Under this Program for Scientific and Technological Cooperation Dr. Jose Lasa of Zaragoza, Spain, and I have had a project funded for the synthesis and testing of experimental hybrids for their potential use in Spain and the U.S. A number of experimental hybrids have been generated using diploid and tetraploid Spanish pollinators, some with high levels of leaf spot resistance, and U.S. male steriles which are publicly available, having been released to the BSDF for more than five years. The first preliminary test of these hybrids was conducted in 1981 at Fort Collins and at four locations in Spain. The yields of the most superior hybrids in the Fort Collins test are shown in Table 1. A few of these hybrids are significantly higher in sucrose yield than the local check, however, most of the hybrids are lower than the check in sucrose content. The better hybrids in this 1981 test will be retested at Fort Collins in 1982.

Table 1. Yield test of the most superior experimental hybrids involving previously released US male steriles and Spanish pollinators (7,81).

Entry no.	Hybrid	Recov. suc. (T/A)	Root yield (T/A)	Sucrose (%)	T.J. purity (%)
1059	[(FC504CMS X FC502/2)XFC603]X 724102	3.38	30.2	13.8	86.2
1031	FC504CMS X 72496	3.35	30.9	13.4	85.9
1077	(FC506CMS X 562) X 41(4χ)	3.29	26.3	15.5	88.0
1113	(SLC129CMS X SLC133) X 81 B.20-22(4χ)	3.24	27.9	14.7	87.4
1050	FC504CMS X 724102	3.23	30.7	13.1	86.2
1052	(FC504CMS X FC502/2) X 645-78	3.20	25.1	15.8	88.1
1013	[(FC504CMS X FC502/2)XFC603]X 645-78	3.14	24.4	15.9	88.2
1090	FC505CMS X 81 B.20-22 (4χ)	3.14	26.1	14.8	86.4
1097	(FC504CMS X FC502/2)X 72496	3.13	29.9	13.2	85.6
1070	(FC506CMS X L-36)X 645-78	3.11	27.0	14.2	87.0
1042	FC505CMS X 41(4χ)	3.09	24.9	15.2	87.2
1043	(562CMS X 546)X 72496	3.08	29.4	13.2	85.5
1060 1087	Mono Hy D2 (check)	2.93	24.0	15.1	87.6
	LSD (.05)	0.32	2.9	1.2	1.8

SUGARBEET RESEARCH

1981 Report

Section D

North Dakota Agricultural Experiment Station, Fargo, North Dakota

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Cooperation:

American Crystal Sugar Company
Minn-Dak Sugar Cooperative
Minnesota Agricultural Experiment Station
Sugarbeet Research and Education Board of Minnesota and North Dakota

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CONTENTS

SUGARBEET DISEASE RESEARCH - 1981

W. M. Bugbee

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Bacterial root inhabitants

Freshly harvested roots of sugarbeet possess low levels of acid invertase activity. Acid invertase and invert sugars increase and sucrose decreases during root storage. Enzymatic destruction of sucrose and accumulation of invert sugars in stored roots of sugarbeet was caused by at least three forms of microbial invertase and not by an acid invertase of root origin. Invertase-producing bacteria were found within and between xylem and live parenchyma cells of healthy sugarbeet roots. Invertase activity was not detected in recently harvested roots, but there was activity in roots stored at 4 to 6 C, 20 to 23 C, or in artificially aged root tissue. Comparison of molecular weight (MW) of invertases separated on gel columns showed two acid invertases from stored roots were similar to those of yeast (205,000) and bacteria (158,000). Acid invertase (presumably of sugarbeet origin) from aged root tissue had an estimated MW of 33,000. Extracts from roots kept at 20 to 23 C for 21 days also had a neutral invertase, MW 18,200, that was similar to invertase found in extracts of bacteria isolated from sugarbeet roots.

Scanning electron microscopy showed openings in root cell walls large enough for bacteria to pass through. Some of the holes appeared to originate in primary pit fields. Bacteria were adjacent to these holes. Some of the bacteria that were isolated from roots possessed cellulase but none were pectolytic. The lack of pectolytic activity by these parasitic bacteria makes it difficult to theorize that bacteria cause local wall dissolution because pectinase would be required for dissolution of the middle lamella. Therefore, the mechanism of cell penetration by bacterial parasites was not determined.

Three attempts to grow sterile sugarbeets in a germfree chamber failed because of our inability to completely disinfect seedlings and failure to establish complete sterility within the chamber.

Cercospora and systemic fungicides

The lack of leafspot control this past growing season after systemic fungicides were applied may have been due, in part, to strains of Cercospora that were resistant to the fungicides. Three problem fields in the Renville district were sampled and all of the 36 cultures of Cercospora were resistant to the systemic fungicides Mertect, Benlate and Topsin-M. Fifteen Cercospora cultures from four fields in the Min-Dak district were sensitive to these fungicides.

SUGARBEET PHYSIOLOGY

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Selection for Internal CO_2 in Sugarbeet Roots

Recent data showed that internal CO_2 levels in sugarbeet roots differ among lines and cultivars, that CO_2 levels are influenced by storage temperature, that CO_2 levels are not affected by resident bacteria, and that internal CO_2 levels are correlated with respiration rates in stored sugarbeet roots.

Selection for low and high levels of internal CO_2 was initiated in 1975. Two lines that exhibited high and low levels of CO_2 were developed.

A field study was initiated in 1980 to evaluate progress in changing internal CO_2 levels of the lines compared to the original population. Plots were 2 rows wide and 9.1 m long with 4 replications. Seed of the low and high CO_2 lines and a commercial cultivar were planted in a randomized complete block design on May 12, 1980, and irrigated on June 3. Roots were harvested on October 5 and stored at 5 C and near 100% R.H. Sucrose, purity, and sucrose per ton was determined on a subsample of roots at harvest using standard procedures. Roots (8-11 per plot) were evaluated for internal CO_2 after 90 days storage.

Selection for low and high levels of internal CO_2 were effective in changing internal CO_2 levels from the original population (Table 1). The level of CO_2 was decreased 20% in the low population and increased 20% in the high population. The commercial cultivar was intermediate to the low and high population.

No definite trends in quality parameters were identified (Table 1). Purity was not affected by population or selection. Sucrose and sucrose per ton appeared to be increased by selecting for high internal CO_2.

Seventeen roots of the low population were planted in a greenhouse and 19 roots of the high population were planted in a different greenhouse in the spring of 1981. The plants were allowed to interpollinate and seed was bulked from all plants within a population. The bulked seed will be released to breeders upon clearance by USDA and North Dakota personnel. Seed will be available in 5 g quantities to sugarbeet breeders upon written request and agreement to make appropriate recognition of its source as a matter of open record when this germplasm contributes to the development of a new cultivar.

Effect of Simulated herbicide spray drift on storage losses

Over 87% of the wheat and barley acreage in North Dakota was treated with one or more herbicide applications in 1978. 2,4-D was the most widely used

herbicide in wheat although dicamba and picloram were also used extensively for selective control of broadleaf weeds in cereal crops. The potential for herbicide drift to susceptible crops exists when substantial acreages are treated with herbicides such as 2,4-D, although economic losses from herbicide drift are not widespread in North Dakota. However, individual farmers with crops affected by herbicide drift can have substantial losses.

Schweizer reported that 2,4-D at rates as low as 0.017 kg/ha reduced extractable sucrose from the combined efects of increased impurities, decreased root yield, and decreased percent sucrose. Sugarbeets are most subject to injury from spray drift in May or June when broadleaf weeds are treated in cereal crops in North Dakota and Minnesota. This early season herbicide exposure may reduce yield components at harvest but additional extractable sucrose losses may occur during storage before processing.

Therefore, the objectives of this research were to determine: (a) sugarbeet root yield and extractable sucrose at harvest; and (b) sucrose losses during storage as influenced by 2,4-D, dicamba, and picloram at low rates to simulate spray drift on sugarbeets at various growth stages.

Field experiments. 'ACH17' sugarbeet was seeded 3.8 cm deep in rows 56 cm apart in a Fargo silty clay soil at the Agricultural Experiment Station, Fargo, ND, on May 4, 1978, and May 21, 1979. The sugarbeets were thinned on June 10, 1978, and June 14, 1979, and hand weeded during the remainder of the growing season. Herbicides were applied in 160 1/ha of water at 2.81 kg/cm^2 of CO_2 with a bicycle wheel sprayer equipped with a wind shield. Plots were four rows wide by 10.7 m long in a randomized complete block design with six replications. 2,4-D, dimethylamine, at 0.035, 0.14, and 0.28 kg/ha was applied on May 30, 1978, when the sugarbeets had 2 to 4 leaves and thereafter at 2-week intervals until July 25, 1978, when the sugarbeets had 30 to 40 leaves. In 1979 the first application of 2,4-D was made on June 14 when the sugarbeets ranged in size from cotyledonary to the 4 leaf stage. Subsequent applications were made at 2-week intervals until August 7, 1979, when the sugarbeets had about 40 to 50 leaves. Dicamba, dimethylamine, at 0.017, 0.07, and 0.14 kg/ha and picloram, potassium salt, at 0.007, 0.014, and 0.028 kg/ha were applied only at the 12 leaf stage of the sugarbeets on June 20, 1978, and July 6, 1979. The center two rows of each plot were hand harvested on September 28, 1978, and October 1, 1979. All data was combined over years and subjected to an analysis of variance with single degree of freedom orthogonal comparisons with partitioning of treatment sums of squares by herbicides, rates, growth stages, and years.

Storage experiments. Storage samples were randomly selected from the harvested sugarbeet roots in 1978 and 1979. Sugarbeet roots were washed, placed in perforated plastic bags, weighed and stored at 5C and 95% R.H. for 150 days in 1978 and 110 days in 1979. The sugarbeet roots were reweighed at the end of the storage period to determine weight loss. Sugarbeet quality determinations at harvest were compared to quality determinations after storage to determine sucrose losses and changes in purity during storage.

Sugarbeet quality determinations. Sugarbeet pulp and juice extract samples were obtained at harvest and after the storage period. The harvest and storage samples were frozen and then analyzed at the same time. The sugarbeet quality parameters determined were sucrose, purity, raffinose,

invert sugars, and extractable sucrose. Corrections for raffinose and invert sugars were made on the 1979 storage data but not on the 1978 storage data. Extractable sucrose per ton of roots was calculated with an assumed factory loss of 0.3% and a molasses purity of 62.5%.

Sucrose components after storage. The year by sucrose, year by purity, and year by extractable sucrose interactions were not significant for the storage experiments. Therefore, these data were averaged across years.

Sugarbeet roots from plants treated with 2,4-D simulated spray drift tended to have greater sucrose losses than the control during storage regardless of growth stage when the treatments were applied (Table 2). Sucrose losses during storage from sugarbeets treated at the early growth stages did not differ from the control. However, when 2,4-D was applied at the later growth stages, sucrose losses during storage were greater than the control. Purity and extractable sucrose losses during storage did not differ from the control although the losses tended to be greater than the control regardless of the growth stage of the sugarbeets when the 2,4-D treatments were applied. Extractable sucrose losses varied from 21.2 to 27.0 kg/t with a tendency for the greatest loss from 2,4-D applied at growth stage 3. Sucrose losses during storage, expressed as a percent of the control at harvest, were 20% for untreated sugarbeets. Sucrose losses during storage did not differ among growth stages when the 2,4-D was applied but losses varied from 28 to 37% which tended to be greater than the control. Dicamba and picloram treatments also tended to decrease sucrose and purity in sugarbeets during storage. Dicamba treatments tended to cause more extractable sucrose losses than the picloram treatments, but both dicamba and picloram had less effect on sugarbeets during storage than the 2,4-D treatments at comparable growth stages.

Losses of sucrose, purity, and extractable sucrose during storage increased with increasing rates of 2,4-D, dicamba, and picloram (Table 3). Sucrose losses during storage, expressed as a percent of the control at harvest, show losses of 20% for the untreated sugarbeets. Sucrose losses during storage did not differ among herbicides or rates but losses varied from 22 to 39% which tended to be greater than for untreated sugarbeets.

Sucrose loss during post-harvest storage of sugarbeets can average 0.23 kg/t/day and is a major concern of the sugarbeet industry of North Dakota and Minnesota. Additional sucrose losses can occur during processing and tend to increase with length of storage period. Raffinose and invert sugars which accumulate in the sugarbeet root increase the amount of molasses produced and thus reduce the amount of sucrose extracted. Sugarbeet root respiration accounts for 50 to 60% of the sucrose loss during storage in the Red River Valley of North Dakota and Minnesota while storage pathogens account for an additional 10% of the sucrose loss. The remaining sucrose losses can be attributed primarily to raffinose and invert sugar accumulations in the roots. The levels of raffinose accumulation during storage are related to varietal characteristics, but invert sugar accumulations appear related to temperature-varietal interactions.

Sugarbeets exposed to 2,4-D, dicamba, and picloram as simulated spray drift treatments tended to have greater losses of extractable sucrose during storage than untreated beets (Table 2). However, there were no differences between the three herbicides when averaged over years. Differences in extrac-

table sucrose between years indicate that environmental conditions during the growing season have an important effect on the storage of sugarbeet roots. Extractable sucrose losses during storage in 1978 ranged from 32% for untreated sugarbeets to 57% for sugarbeets treated with 2,4-D. However, in 1979 only 9% of the extractable sucrose in untreated sugarbeets was lost during storage while extractable sucrose losses up to 31% occurred in sugarbeets treated with 2,4-D. Previous data indicated that sugarbeets grown under low moisture not only had a lower percent sucrose content at harvest than sugarbeets grown under more optimum moisture but also had higher levels of invert sugars after storage. The differences in rainfall between years thus may have contributed to the storage losses. The weather patterns between 1978 and 1979 were markedly different and the storage effects are probably a reflection of these weather differences. Rainfall for the growing season of March to October 1978 was approximately 5.7 cm below normal while average monthly temperatures for the same period were 1.1C above normal. The same period in 1979 had slightly above normal rainfall while average monthly temperatures were 1C below normal.

Sugarbeets which are inadvertently exposed to 2,4-D, dicamba, or picloram spray drift during the growing season should be processed immediately at harvest. Post-harvest storage of sugarbeets exposed to herbicide spray drift would not only result in storage of lower quality sugarbeets but would also increase the potential for increased sucrose losses in the storage pile.

Resident Microflora in Sugarbeet Roots

Over 2 million tons of sugarbeet roots were exposed to temperatures below 25 F for several hours in the fall of 1981 during the harvest period. Processors noted difficulties in processing the frozen beets and storage losses increased. Previous data showed that the resident microflora of sugarbeet roots increased during storage and that sucrose losses were extremely large under anaerobic conditions.

A preliminary study was initiated to determine the effect of low temperatures in the field on storage losses and the effect on the population of the resident microflora population. A sample of sugarbeet roots were harvested 2 days before the low temperatures in the field caused frost damage. Another sample of roots were harvested 10 days after the low temperatures. The roots that were exposed to the freezing temperature were defoliated while frozen (1 day after the temperature dropped) and remained in the field. The roots harvested before the freeze were defoliated the day of harvest. The plots were 4 rows wide and 9 m long with 5 replications.

After harvest, the roots were stored at 5 C and near 100% R.H. for 50 and 38 days for the non-frozen and frozen samples, respectively. Cores (1x5 cm) were removed from the root (6 cm below the lowest leaf scar) and crown (0.5 cm above the lowest leaf scar) tissue of four roots per replicate. Juice was obtained from the cores, diluted and plated in tripliate by the four-plate technique to determine the resident microflora population.

The number of the microflora per ml of juice was significantly affected by type of leaf removal, type of tissue, and by freezing temperatures (Table 4). Interactions between the variables were not significantly affected.

The increase in the microflora induced by the freezing temperatures may partially explain why the frosted beets were difficult to process. The microflora (both bacteria and yeast) were not identified to genus and species in this preliminary test. However, previous data confirms that both bacteria and yeast are present in sugarbeet roots. Also, several microorganisms are known to produce compounds (dextrans, etc.) which affect processing qualities.

After 120 days storage, the roots will be removed from storage to determine storage losses. Some of the samples will be assayed for compounds which are known to affect processing qualities to determine if there is a relation to frost damage.

Response of Sugarbeet Cultivars to EPTC, Desmedipham and Temik

Previous data indicated that some cultivars may be more susceptible to damage caused by the herbicides EPTC and Desmedipham. EPTC is applied as a preplant incorporated either in the fall or spring and Desmedipham is applied as a post-emergence treatment. Previous data indicated that EPTC may reduce losses of sucrose during post-harvest storage.

A large acreage of sugarbeets are treated with one or more herbicides for weed control and an insecticide for control of various insects. No data is available to indicate the effect of multiple pesticide applications on losses of sucrose during post-harvest storage. The objectives of this research were to determine the effect of EPTC, Desmedipham, and Temik used alone and in all combinations on yield, quality, and losses of sucrose during storage.

Tests were conducted in 1980 on a sandy loam (Moorhead, MN) and on a heavy clay (Fargo, ND) soil in 1980. The test was repeated at the Fargo location in 1981. EPTC, Desmedipham, and Temik were applied at recommended rates and time of application. Three cultivars, GW Mono-Hy R1 (R1), Hilleshog Mono 833 (833), and American Crystal Hybrid 30 (ACH 30), were planted in a randomized complete block design with 6 and 8 blocks in 1980 and 1981, respectively. Cultivars were selected from preliminary data by Alan Dexter and John Kern obtained in the Red River Valley.

The plots were 4 rows wide and 7.5 m long. The plots were maintained weed free after the Desmedipham treatment and a protectant fungicide was applied at the Fargo location in 1981. Sugarbeet roots were manually harvested, washed, and stored at 5 C and near 100% R.H. for 120 days. Sucrose, purity, and sucrose per ton were determined at harvest and after storage. Standard laboratory procedures were utilized.

Cultivars were significantly different in recoverable sucrose per ton at harvest and after storage in 1980 (Table 5). Desmedipham caused a significant reduction in sucrose per ton at harvest at the Fargo location. EPTC and Temik did not significantly affect quality at harvest or after storage at either location. Interactions among the parameters were not consistent across locations in 1980. Some interactions were significant at harvest but not after storage and vice-versa.

Yield was significantly different among cultivars at both locations. R1 yielded 2.3 and 2.5 tons more than 833 ACH 30, respectively, at the Moorhead

location in 1980. At the Fargo location, 833 yielded 0.9 and 3.5 tons more than R1 and ACH 30, respectively. The Moorhead location was heavily infected with Cercospora leaf spot, whereas, the Fargo location had only a limited amount of leaf spot. Cultivar 833 is more susceptible to leaf spot than R1 or ACH 30.

In 1981 at Fargo, 833 yielded 0.8 and 3.7 tons more than R1 and ACH30, respectively. This is similar to the 1980 result at Fargo. ACH 30 was significantly higher in recoverable sugar per ton at harvest in 1981. Storage data are not complete for the 1981 experiment.

Table 1. Effect of selection for internal CO_2 on internal CO_2, sucrose, purity, and sucrose per ton in sugarbeet roots.

Population	Selection Cycle		
	Original	1	2
		internal CO_2, %	
Low	1.83 cd *	1.68 cd	1.46 d
High	2.57 b	3.07 a	3.08 a
Commercial	2.02 c		
		sugar, %	
Low	14.1 ab	14.6 a	12.9 bc
High	12.5 c	12.4 c	13.8 ab
Commercial	13.6 abc		
		purity, %	
Low	89.7 a	90.4 a	88.3 a
High	88.8 a	89.5 a	89.7 a
Commercial	89.8 a		
		sucrose per ton, lbs	
Low	223 ab	236 a	196 bc
High	192 c	195 bc	219 abc
Commercial	215 abc		

* Means followed by the same letter within a variable are not significantly different at the 0.05 level according to Duncan's Multiple Range Test.

Table 2. Percent sucrose, purity and extractable sucrose losses of sugarbeets during storage[a] as influenced by 2,4-D, dicamba, and picloram spray drift treatments averaged over herbicide rates and years.

Herbicide	Application date	Sucrose loss (%)	Purity loss (%)	Extractable sucrose losses (kg/T)	Extractable sucrose losses (% of control at harvest)
2,4-D	1	2.7	4.4	23.6	34
2,4-D	2	2.9	4.0	23.8	31
2,4-D	3	3.5	5.6	27.0	37
2,4-D	4	3.4	7.9	24.8	32
2,4-D	5	3.2	7.8	21.2	28
Dicamba	-	2.6	3.9	21.5	29
Picloram	-	2.4	3.2	19.5	28
Control	-	2.1	2.6	16.2	20
LSD .05		1.1	6.8	10.8	16

[a]Stored at 5C and 95% R.H. for 150 days and 110 days during the 1978-1979 and 1979-1980 storage periods, respectively.

Table 3. Percent sucrose, purity, and extractable sucrose losses of sugarbeets during storage[a] as influenced by 2,4-D, dicamba, and picloram spray drift rates averaged over application dates and years.

Herbicide	Rate kg/ha	Sucrose loss (%)	Purity loss (%)	Extractable sucrose losses (kg/T)	Extractable sucrose losses (% of control at harvest)
2,4-D	.035	2.4	3.0	19.5	27
2,4-D	.140	3.4	6.0	25.5	34
2,4-D	.280	3.6	8.9	27.2	36
Dicamba	.017	1.8	2.8	16.3	22
Dicamba	.070	3.3	5.1	27.9	39
Dicamba	.140	2.7	3.8	20.3	25
Picloram	.007	2.1	2.5	18.0	24
Picloram	.014	2.3	2.6	17.5	27
Picloram	.028	2.8	4.7	22.9	34
Control	--	2.1	2.6	16.2	21
LSD .05		1.1	6.8	10.8	16

[a] Stored at 5C and 95% R.H. for 150 days and 110 days during the 1978-1979 and 1979-1980 storage periods, respectively.

Table 4. Effect of freezing, tissue, and type of leaf removal on the resident microflora population of stored sugarbeet roots.

Variables					
Frozen	Tissue	Type of leaf removal	# Microflora per ml of juice	Variable	# Microflora per ml of juice
			$X10^6$		$X10^6$
No	Crown	Flailed	1.12	Flailed	3.19 b*
		Scalped	3.25	Scalped	5.96 a
	Root	Flailed	0.78		
		Scalped	2.56	Crown	5.91 a
Yes	Crown	Flailed	6.60	Root	3.24 b
		Scalped	12.65		
	Root	Flailed	4.24	Frozen	7.21 a
		Scalped	5.36	Non-frozen	1.93 b

* Means followed by the same letter are not significantly different according to Duncan's Multiple Range Test.

Table 5. Effect of cultivar, EPTC, Desmedipham, and Temik on recoverable sugar per ton in 1980.

	Fargo			Moorhead		
Variable	Harvest	Storage	% Loss	Harvest	Storage	% Loss
Cultivar						
ACH-14	252* a	239 a	5.2	261 a	243 a	6.9
GW-R1	230 b	213 b	7.3	249 ab	226 ab	9.2
BJ-833	236 b	216 b	8.4	237 a	214 b	9.7
EPTC						
No	237 a	220 a	7.1	249 a	229 a	8.0
Yes	242 a	225 b	7.0	249 a	226 a	9.2
Desmedipham						
No	243 a	224 a	8.2	248 a	227 a	8.5
Yes	235 b	222 a	9.8	250 a	228 a	8.8
Temik						
No	238 a	222 a	6.7	247 a	226 a	8.7
Yes	241 a	223 a	7.5	251 a	229 a	8.8

* Means followed by the same letter within a variable, location, and time of harvest are not significantly different according to Duncan's Multiple Range Test at the 0.05 level of probability.

SELECTION FOR IMPROVED STORABILITY

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The possibility of selecting genotypes exhibiting reduced sucrose losses during storage has been advocated for some time. Research in the early 1950's demonstrated the possibility of selecting for storage rot resistance and low respiration rate during storage; however, this was not pursued until the late 1970's.

In 1978 the world collection was screened for response to three important storage rot fungi (Phoma betae, Botrytis cinerea, and Penicillium claviforme) and for low respiration rate (internal CO_2 concentration) during storage. Selected individuals were polycrossed and progeny tested in 1979. Superior lines were increased and examined in a replicated trial for the first time in 1980 (Table 1). Selection for rot resistance appeared to be effective in most cases. Almost all selections exhibited higher levels of resistance for the selected trait than F1001, a rot resistant line released in 1977. Several lines were resistant to two rot organisms and a few appeared to be at least moderately resistant to all three organisms. Selection response for low respiration was also favorable. Some low respiration lines also have some resistance to one or more rot organisms. These data indicate that resistance to all three rot organisms and low respiration can eventually be combined into a single line or population. This material has been selected almost exclusively for improved storability; consequently, sucrose levels and purities are generally below acceptable levels.

Table 1. Characterization of lines selected for resistance to storage rot fungi and reduced respiration during storage.

	Phoma	Botrytis	Penicillium	Respiration rate	Sucrose	Purity
	rating †			%CO_2	%	
			Phoma selections			
	3.5 c-f*	3.2 c-f	2.5 k-l	1.87 b-e	6.2	72.9
	1.8 i-l	3.3 c-f	4.0 a-h	2.17 b-c	10.4	82.6
	1.5 j-l	1.5 kl	4.0 a-h	2.09 b-d	9.7	81.8
	1.8 i-l	1.3 l	2.8 j-l	2.14 b-c	9.8	79.8
	1.3 k-l	1.7 i-l	3.0 h-l	2.24 b	9.4	79.6
	2.4 g-k	2.8 d-i	3.1 g-l	1.96 b-e	8.0	79.2
	3.0 c-h	2.3 f-l	2.8 j-l	1.42 g-k	7.1	76.2
	2.7 c-i	2.3 f-l	3.4 e-k	1.73 d-h	7.8	80.1
	2.2 g-l	2.4 e-l	3.9 b-i	1.87 b-e	9.3	85.0
	2.6 e-i	3.5 b-e	3.6 d-j	1.60 e-i	8.5	78.7
	1.8 i-l	2.5 e-k	2.2 l	1.60 e-i	7.0	72.6
Mean	2.2	2.4	3.2	1.88	8.5	79.0

Table 1 Cont.

	Phoma	Botrytis	Penicillium	Respiration rate	Sucrose	Purity
	rating †			$\%CO_2$	%	
			Botrytis selections			
	2.1 g-l	1.8 i-l	2.8 j-l	1.90 b-f	8.4	78.3
	1.2 l	1.6 j-l	3.3 f-k	2.10 b-d	8.7	79.8
	1.3 k-l	1.7 i-l	3.0 h-l	2.24 b	9.4	79.6
	1.8 i-l	2.5 e-k	2.2 l	1.60 e-i	7.0	72.6
Mean	1.6	1.9	2.8	1.96	8.4	77.6
			Penicillium selections			
	3.0 c-h	2.3 f-l	4.6 a-d	2.06 b-d	9.9	83.1
	2.5 e-i	2.1 g-l	3.0 h-l	1.83 c-f	7.6	79.4
	1.8 i-l	2.5 e-k	2.2 l	1.60 e-i	7.0	72.6
	2.8 c-i	1.8 i-l	2.5 k-l	1.86 b-f	7.0	77.0
Mean	2.5	2.2	3.1	1.84	7.9	78.0
			Low respiration selections			
	4.6 a	4.3 a-c	4.0 a-h	1.19 jk	8.9	80.3
	3.8 a-c	3.7 a-d	3.9 b-i	1.54 f-j	7.4	80.0
	2.4 g-k	4.4 ab	4.9 a	1.42 g-k	11.8	85.7
	4.3 ab	2.7 d-i	2.5 k-l	1.27 i-k	6.6	81.1
	3.8 a-d	3.7 a-d	4.3 a-f	1.33 i-k	6.9	78.9
	3.0 c-h	2.9 d-h	3.3 f-k	1.65 e-l	8.7	82.1
	2.7 c-i	2.6 d-k	3.4 e-k	1.17 jk	7.5	79.2
	4.6 a	4.3 a-c	3.7 d-j	1.10 k	5.2	79.4
	4.6 a	4.1 a-c	4.2 a-g	1.10 k	7.9	78.4
	3.0 c-h	4.4 a-b	4.3 a-f	1.58 e-i	9.1	81.5
	4.6 a	4.2 a-c	4.5 a-e	1.16 jk	7.7	82.9
	2.9 c-i	1.7 i-l	3.0 h-l	1.36 h-k	7.8	78.0
	2.7 c-i	1.6 j-l	2.8 i-l	1.42 g-k	7.1	78.1
Mean	3.6	3.4	3.8	1.33	7.9	80.4
			Checks			
F1001	2.8 c-i	2.6 d-k	3.6 d-j	2.64 a	9.2	81.6
ACH 14	3.1 c-g	4.1 a-c	4.8 a-c	1.91 b-f	12.3	86.6
GW R1	3.5 c-e	4.8 a	4.9 a	1.78 d-g	11.3	88.1

† Rot rating indicates the distance rot progressed through a 1 cm^2 block of root tissue after incubation at 20 C for 2 weeks. 0 = 0 mm; 1 = not over 2 mm; 2 = 2-4 mm; 3 = 4-6 mm; 4 = 6-8 mm; 5 = 8-10 mm (entire block).

* Means of 4 replications; means within a column followed by a common letter are not significantly (P = 0.05) different according to Duncan's multiple range test.

Two populations including 1861, L53, C17, GW-D2, and low respiration selections in their parentage were examined for respiration rate and sucrose concentration on an individual root basis (Table 2). Population means for sucrose percent and respiration rate were lower than the check while variances were larger. The low correlation between sucrose and respiration rate would indicate that these characters are not closely associated and selection of low respiration high sucrose lines is possible.

Table 2. Respiration rates and sucrose concentrations of selected populations.

Population	Respiration rate		Sucrose		Correlation
	mean	range	mean	range	sucrose vs respiration
	---- $\%CO_2$ ----		---- % ----		
1	1.46	0.64-3.72	10.8	6.0-15.5	0.019
GW-R1	1.54	0.82-2.44	11.0	7.2-13.7	
2	1.69	0.85-4.39	10.4	5.7-15.1	0.023
GW-R1	1.76	1.25-3.08	11.1	8.2-13.6	

Progress to date indicate that significant improvements in storability are possible, that traits related to storability can be combined in a single line, and that acceptable levels of sucrose can be maintained in lines with improved storability.

SUGARBEET RESEARCH

1981 Report

Section E

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Farmers and Manufacturers Beet Sugar Association
Michigan Sugar Company
Monitor Sugar Company
Michigan Agricultural Experiment Station

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CONTENTS

Hybrid Evaluations

G. J. Hogaboam and J. W. Saunders

The seed for the hybrids presented in Experiment 2 was provided by Dr. G. E. Coe as well as were the Beltsville leaf spot readings. The hybrids were evaluated at the Saginaw Valley Bean-Beet Research Farm (B&B). Sugar and purity analyses were provided by the Farmers and Manufacturers Beet Sugar Association (F&M).

The F&M-USDA new hybrids test was conducted at two locations. We are indebted to the F&M and the American Crystal Sugar Company for raising test quantities of these hybrids in their pollinator fields and providing them to us for testing. The last 4 entries were provided by Dr. G. E. Coe. The F&M conducted the tests and quality evaluations.

The seed for the hybrids presented in Experiment 7 was provided by Dr. Richard Hecker for evaluation at the B&B farm and in our Rhizoctonia nursery.

Performance tables for the above hybrid tests are on the following pages.

Papers Published in 1981

HOGABOAM, G. J., ZIELKE, R. C., and SCHNEIDER, C. L. 1981. Notice of release of sugarbeet breeding line EL40.

HOGABOAM, G. J., SCHNEIDER, C. L., and COE, G. E.. 1981. Notice of release of sugarbeet hybrid US H23 for grower use.

HOGABOAM, G. J., SCHNEIDER, C. L., and COE, G. E. 1981. Notice of release of sugarbeet hybrid US H20A for grower use.

SMUCKER, A. J. M., ADAMS, M. W., CHRISTENSON, D. R., and HOGABOAM, G. J. 1981. Drybean and sugarbeet shoot responses to minimum and excessive secondary tillage and traffic compaction. Agronomy abstracts.p 114.

SAUNDERS, J. W., and DAUB, M. E. 1981. Habituation and shoot regeneration in callus from sugarbeet (Beta vulgaris L.) shoot cultures. Agronomy Abstracts. p 72.

Experiment 2. Experimental monogerm hybrids from Beltsville.

Seed No.	RWSA	T/A	RWST	% Sucrose	% CJP	Leaf spot† Belt. 8-10	Leaf spot† E.L. 8-25
79320-01 x 78256-0	5050	21.59	234.4	14.35	93.11	12	11
79323-01 x "	4810	20.75	232.4	14.45	92.34	12	11
79325-01 x "	5479	23.00	238.0	14.53	93.25	15	-
8023H-02	5469	23.14	235.5	14.59	92.48	13	-
79331-01 x 78256-0	5396	23.06	233.7	14.43	92.69	13	11
8023H-03	5342	23.66	224.8	14.21	91.57	11	9
79335-01 x 78256-0	5614	24.51	230.0	14.18	92.80	12	10
79342-01 x "	4610	19.39	236.8	14.53	92.97	12	10
80645-01 x "	5687	23.76	238.6	14.64	92.93	14	-
US H20	6185	25.83	239.4	14.57	93.37	15	-
76682-01 x 78256-0	5976	24.99	238.2	14.63	92.88	12	-
75756-01 x "	5175	20.96	247.1	14.90	93.80	11	-
(71550-01 x 74570-0) x "	4829	20.48	236.4	14.42	93.31	10	-
(77577-01 x ") x "	5175	22.40	231.0	14.14	93.13	12	-
(76590-01 x ") x "	5214	21.28	245.3	14.76	93.94	11	-
8023H-07	5037	20.01	251.2	15.08	94.00	9	-
(76595-01 x 74570-0) x 78256-0	4317	17.81	241.9	14.67	93.55	12	-
8023H-08	5026	20.93	239.9	14.65	93.19	9	-
(76579-01 x 74570-0) x 78256-0	4544	18.57	244.3	14.78	93.63	11	-
(1861x12166) x 77260-00	6815	27.80	245.3	14.82	93.71	15	-
(78615-01 x 74570-0) x 78256-0	5921	24.85	237.7	14.66	92.70	11	-
8023H-09	6128	26.66	229.5	14.24	92.45	11	-
(78616-01 x 74570-0) x 78256-0	5861	24.60	238.2	14.57	93.11	11	-
(78617-01 x ") x "	4833	19.66	246.6	14.81	94.01	11	-
(78619-01 x ") x "	5657	22.88	246.5	14.86	93.80	11	-
(78622-01 x ") x "	5128	21.18	243.1	14.78	93.36	11	-
(78641-01 x ") x "	5575	23.25	239.6	14.50	93.69	11	-
(78682-01 x ") x "	6247	27.13	230.3	14.21	92.75	11	-
(77756-01 x ") x "	5041	21.52	235.3	14.38	93.19	13	-
US H20	5956	24.23	245.4	14.92	93.35	15	-
(74324x1 x 74566-0) x 78256-0	5393	23.16	232.1	14.36	92.57	13	-
8023H-01	4934	22.09	222.6	14.00	91.86	11	-
(77576-01 x 79624-0) x 78256-0	5179	22.45	228.9	14.48	91.49	13	-
(" x 79626-0) x "	5453	24.00	226.9	14.10	92.42	13	-
(78682-01 x 79627-0) x "	5597	24.40	229.0	14.24	92.39	11	-
(77576-01 x 79628-0) x "	4925	21.42	229.5	14.22	92.53	12	-

† 3 plot total readings

F&M - USDA New Hybrids Test - 1981

Richville, Michigan

Hybrid	RWSA	T/A	RWST	% Sucrose	% CJP	Beets /100 ft.
SP74566-01 x SP76745-0 x EL40	7154	28.70	249	15.31	92.73	91
SP74564-01 x FC506 x EL40	7159	28.05	257	15.67	92.98	85
EL44ms x FC506 x EL40	7421	27.87	265	15.96	93.68	85
SP7542-01 x FC506 x EL40	7223	26.81	269	16.16	93.77	78
EL36ms x FC506 x EL40	7349	28.36	259	15.72	93.34	87
US H20	6704	27.56	243	15.00	92.64	81
SP74320x1 x SP74566-0 x EL40	7623	29.97	254	15.51	92.99	86
SP77756-01 x SP79626-0 x EL40	7525	28.78	262	15.90	93.16	83
SP76682-01 x SP79627-0 x EL40	7280	28.78	253	15.46	93.04	84
FC607ms x EL40	7538	29.89	252	15.36	93.04	86
FC607ms x SP6822-0	5818	23.43	249	15.32	92.60	60
FC606ms x SP6822-0	6115	24.99	245	15.08	92.63	56
US H23	7177	27.04	266	16.04	93.51	78
US H23(B-11)	7366	27.92	264	15.95	93.51	77
UI1861 x 12166 x SP77260-00	5941	24.94	238	14.84	92.12	57
SP74340-01 x SP74566-0 x SP77260-00	6771	26.96	252	15.47	92.70	60
SP74320-01 x SP74566-0 x SP77260-00	6455	27.40	236	14.72	92.10	60
SP74325-01 x SP74566-0 x SP77260-00	6783	28.80	235	14.71	92.03	70
GEN. MEAN	6967	27.57	240	15.45	92.92	76
LSD (5%)	868	3.20	13	0.54	0.77	11
CV (%)	10.8	10.1	4.6	3.0	0.7	12.1

Location: Rudy Mossner Farm
Cooperation: USDA; Michigan Sugar Company; F&M Beet Sugar Assn.
Planted: April 21 Harvested: October 12 Row Width: 28 inches
Disease: Severe leafspot; some Rhizoctonia crown rot
Reliability of Test: Fair-good; Excess rain in June and September flooded the first 3 reps. Stands affected by poor emergence conditions.

F&M - USDA New Hybrids Test - 1981

B&B Research Farm

Hybrid	RWSA	T/A	RWST	% Sucrose	% CJP	Beets /100 ft.
SP74566-01 x SP76745-0 x EL40	6541	27.12	242	14.96	92.47	86
SP74564-01 x FC506 x EL40	6652	26.44	252	15.44	92.77	90
EL44ms x FC506 x EL40	6568	25.64	257	15.43	93.80	83
SP7542-01 x FC506 x EL40	6284	24.96	252	15.35	93.11	82
EL36ms x FC506 x EL40	6068	24.81	244	15.08	92.53	79
US H20	6768	27.90	243	15.00	92.48	91
SP74320x1 x SP74566-0 x EL40	6474	27.66	234	14.68	91.88	83
SP77756-01 x SP79626-0 x EL40	7102	28.34	250	15.32	92.92	90
SP76682-01 x SP79627-0 x EL40	6586	28.36	233	14.59	91.90	86
FC607ms x EL40	6825	28.49	239	14.88	92.27	91
FC607ms x SP6822-0	6034	24.21	249	15.29	92.81	72
FC606ms x SP6822-0	6023	24.83	242	14.96	92.58	69
US H23	6979	27.09	258	15.50	93.81	93
US H23(B-11)	6457	26.34	245	15.02	92.89	83
UI1861 x 12166 x SP77260-00	5738	24.45	235	14.66	92.06	61
SP74340-01 x SP74566-0 x SP77260-00	6159	26.08	236	14.79	91.92	70
SP74320-01 x SP74566-0 x SP77260-00	5854	24.52	239	14.89	92.09	67
SP74325-01 x SP74566-0 x SP77260-00	6715	28.15	239	14.80	92.46	75
GEN. MEAN	6435	26.41	244	15.04	92.60	81
LSD (5%)	641	2.61	11	0.44	0.75	12
CV (%)	8.7	8.6	3.8	2.6	0.7	12.7

Location: B&B Research Farm
Cooperation: USDA; MSU; Michigan Sugar Company; F&M Beet Sugar Assn.
Planted: May 7 Harvested: October 9 Row Width: 28 inches
Disease: Very mild leafspot
Reliability of Test: Fair-good; stands affected by poor, slow emergence.

Experiment 7. Fort Collins Hybrids and Male Parents Performance at B&B Farm and in Rhizoctonia Disease Nursery.

Hybrid Parentage								
CMS	O Type	Pollen	RWS/A	Tons/A	RWS/T	% Sucrose	% CJP	Rhiz. % Crown Rot
FC506	EL44	FC703/4	3416	15.4	222.7	13.22	94.97	52.9
1861	73747-0	FC705	3520	17.4	203.1	12.66	92.60	49.3
1861	EL44	FC702/7	3669	18.3	200.4	12.59	92.23	49.4
1861	12166	FC705	3827	18.4	207.7	12.89	92.75	50.3
1861	73747-0	FC703/4	3333	16.2	206.4	12.69	93.29	46.1
-	-	FC705/2	2039	11.0	185.6	12.38	89.55	43.7
-	-	FC703/4	2425	11.7	207.0	13.09	91.79	42.8
-	-	FC705	2063	10.9	189.5	12.43	90.27	41.3
-	-	FC702/7	2422	11.0	220.9	13.57	93.12	45.5
		US H20	3745	18.6	201.4	12.40	93.26	71.3
General Mean			2622	14.9	204.5	12.79	92.38	49.2
LSD 5%			655	3.2	7.9	0.38	0.78	16.4
CV %			23.3	20.2	3.6	2.77	0.79	14.2

Rhizoctonia Crown Rot Disease Investigations (Foundation Project 20).

C. L. Schneider

Effect of cropping sequence and rotation period - In a cooperative study with D. R. Christenson, Michigan State University, Crop and Soil Science Dept., incidence of naturally-occurring crown rot was determined at crop maturity in sugarbeet plots of 4 different cropping systems and of 2, 3, and 4-year rotation periods. Plots comprised 8 rows, 66 ft. long. In 1981, with crown rot incidence ranging from 0 to 22% among the 40 sugarbeet plots included in the experiment, there were no significant differences among treatments. For the average of the 1975-1981 period, however, there were significant differences in crown rot incidence among cropping systems with corn-corn-sugarbeet sequence lowest (4.5%) and navy bean-navy bean-sugarbeet sequence highest (7.3%). There were no significant differences associated with rotation periods.

Effect of hilling - The effect of cultivation soil thrown into the crowns was studied in the greenhouse in presence and absence of the pathogen, Rhizoctonia solani. With Rhizoctonia - infested soil, crown rot increased from 45% to 73% and mean root weight decreased from 11.2 to 6.5g in hilled and non-hilled plants respectively. With non-infested soil, no disease or other deleterious effect was noted in hilled or non-hilled plants and root weights were 15.6 and 15.2g respectively.

Aerial photography studies - Investigations were continued on use of aerial photography to evaluate crown rot incidence and severity in experimental plots artificially and naturally exposed to R. solani. Infra red color transparencies of the 1981 Rhizoctonia nursery (1.5 acres) and cropping sequence experiment (6.04 acres) were enlarged to scales of 1:146 and 1:750 respectively. Plot images were graded in regard to relative density of phytomass indicated according to an index from 1 (none) to 9 (luxuriant). In assigning plot ratings, stand, foliage density and color were considered. Plot photo ratings showed a significant negative correlation with field crown rot ratings with r values of -.66** (Rhizoctonia nursery) and -.37* (crop sequence plots). Photo ratings of crop sequence plots also showed significant correlation with harvest stand (r = .57**) and ton/acre root yield (r = .51*).

Fungicide tests - In a field experiment to compare efficacy of 16 fungicide treatments in reducing crown rot, plots of a susceptible commercial sugarbeet cultivar were infested on 16 July with dried barley grain inoculum of R. solani, applied along the rows and into the crowns. On 15 and 30 July, fungicide treatments were applied topically as aqueous sprays at 60 gal/A. or as manually applied granules. At harvest, crown rot incidence and severity in control plots was 73%. Percent crown rot in treatments that significantly reduced disease intensity was as follows: Bayleton 5G, 2.5 and 10 lb/A (37.4% and 54.1%); Terraclor 5G, 15 and 30 lb (47% and 42%); Benlate 50W, 8 oz (54%); Bravo 500 F, 4.25 pints (58%); Rovral 50W, 8 and 16 oz (53% and 48%); Super Tin 4L, 9.6 and 19.2 fl oz (59% and 55%); Topsin 4F, 16.8 fl oz (58%).

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* and ** indicate significance at the 5% and 1% levels respectively.

In a cooperative test with H. S. Potter, Michigan State University, fungicides, Super Tin 4L (9.6 fl oz/A) and Topsin 70W (1 lb/A), were applied by sprinkler irrigation to a planting of US H20 infested with dry millet grain inoculum of R. solani. Sprinkler applications were made in a circular area of 30 ft radius with two replications per treatment. At harvest, mean percent crown rot in treated plots was significantly less than in untreated control plots. Crown rot intensity values for each treatment were as follows: Super Tin (27%), Topsin (38%) and control (48%).

Biocontrol studies - Preparations of fungi, antagonistic to R. solani in vitro, were tested in greenhouse and field for ability to reduce crown rot damage. The antagonists, comprising 5 cultures of Trichoderma and one culture of Corticium had been cultured on nutrient media and dried at the USDA Soilborne Diseases Laboratory, Beltsville, MD. Two Trichoderma preparations and one Corticium preparation that had shown some significant reduction in crown rot in 1980 tests, failed to significantly reduce crown rot in some greenhouse tests in 1981. In a field test, 5 Trichoderma preparations, applied to crowns at 19.5 lb/1000 ft of row with Rhizoctonia barley grain inoculum and covered lightly with field soil, resulted in no significant reduction in crown rot intensity, which in untreated control plots was 60%.

Screening and selecting for Rhizoctonia resistance - In the 1981 Rhizoctonia nursery at East Lansing, 291 entries were tested in plots that had been infested with dry barley grain inoculum and hilled in mid-July, shortly after thinning. At harvest, mean crown rot incidence and severity in check variety plots was as follows: susceptible US H20 = 71%; moderately resistant FC701/5 = 41% and EL42 = 45%. Among the entries, 52% showed significantly less crown rot than US H20.

Studies were continued towards development of improved inoculation techniques and methods of screening for resistance. In a field test to compare efficacy of 3 types of dried grain inoculum, millet inoculum resulted in highest degree of crown rot infection (84%), followed by corn kernel inoculum (78%) and barley inoculum (69%). The millet inoculum, being easiest to prepare and apply, will be tested further for use in field and greenhouse testing. In studies toward development of a greenhouse methodology of screening and selecting for crown rot resistance and tests with dried corn kernel inoculum showed good concordance with field evaluations. In some tests the need for improved control of environmental factors influencing disease development was evident.

Abstracts of Papers Published in 1981

1) Schneider, C. L., R. L. Sims, and H. S. Potter. 1981. Test of fungicides for crown rot control, 1979. In Fungicide and Nematicide Tests 36:55.

Among 7 treatments applied as sprays, the following reduced crown rot infection significantly: Benlate 50W + Du-Ter 47.5W (19g + 19g/km of row); Benlate 50W + Manzate 200 80W (49g + 199g); Bravo 500F (200ml).

2) Potter, H. S. and C. L. Schneider. 1981. Sugarbeet diseases of the North Central United States. North Central Reg. Ext. Publ. 140, 4pp. Ilus.

Seedling blight, root rot, leaf spot, and powdery mildew diseases are discussed with descriptions of symptoms and outlines of general methods of control.

3) Potter, H. S. and C. L. Schneider. 1981. Control of Cercospora leaf spot and Rhizoctonia crown rot diseases of sugarbeet with fungicides applied by sprinkler irrigation. J. Am. Soc. Sugar Beet Technol. 21(1):50-55.

Field tests were conducted in 1976 through 1980 to determine efficacy of irrigation sprinkler application of protective and systemic fungicides in controlling Cercospora beticola leaf spot and Rhizoctonia solani crown rot diseases of sugarbeet. The following significantly reduced leaf spot severity below that of untreated control: benomyl, captafol + captan, chlorothalonil, copper ammonium carbonate, copper salts of fatty and resin acids, cupric hydroxide and fentin hydroxide. The following also significantly reduced crown rot: benomyl, chlorothalonil, and fentin hydroxide.

BREEDING SUGARBEETS FOR RESISTANCE TO BLACK ROOT AND LEAF SPOT

G. E. Coe

Research work on sugarbeets at the Agricultural Research Center, Beltsville, Maryland is directed mainly toward varietal improvement of sugarbeets resistant to Aphanomyces black root and Cercospora leaf spot, important diseases in eastern United States. In addition, in 1981 we have been able to demonstrate some tolerance to Sclerotium rolfsii (southern root rot) as a result of a new technique to select for resistant seedlings. Also, we have demonstrated a reduction in content of nonsucrose solubles resulting from our field selection technique.

Testing for Leaf Spot Resistance

The leaf spot epidemic in 1981 was good but not as severe as the excellent epidemic obtained in 1980. The less resistant plants were eliminated from consideration as breeding material. Selections, however, were based mainly on root size, good sucrose content, and low content of other solubles. Results of the leaf spot nursery test are presented in Table 1.

TABLE 1. Results of leaf spot tests at Beltsville in 1981.

Description	No. Lines Tested	Av. Leaf Spot Rating*		
		Breeding Lines	USH20 Check	Resistant Check
MM lines from Beltsville	74	3.1	4.7	2.8
MM lines from East Lansing	47	3.2	4.7	2.7
mm lines from East Lansing	101	3.0	4.3	2.6
"Soil-free" MM from Beltsville	101	3.4	4.9	2.8
Experimental mM hybrids from Beltsville	34	3.9	5.0	3.0

* 0 = No spots; 10 = All leaves dead.

Seven progenies had excellent leaf spot ratings from 1.3 to 2.0. All of these were above average in root yield. Only five were analyzed for sucrose and total solubles. These five were all above average in sucrose content and lower than average in percent of other solubles. These good qualities are most likely a result of the leaf spot resistance and probably not a reflection of the genetic potential of the breeding line. Selections within these resistant progenies should be made in the absence of leaf spot in order to avoid the effect leaf spot has on root size and sucrose percentage. It is imperative to produce lines from our most leaf spot resistant breeding material with as good combining ability as the components of existing commercial hybrids. This would provide the

resistance necessary to avoid losses caused by leaf spot in years when the climate is most favorable for the disease organism and to prevent the build-up of inoculum caused by using cultivars with insufficient resistance.

Testing for Black Root Resistance

Test for resistance to Aphanomyces blackroot were conducted on about 650 breeding lines and experimental hybrids. Results of most of these tests are presented in Table 2.

Resistance to Aphanomyces black root has improved only slightly with each generation of selection for two reasons most probably. First, heavy selection pressure has not been applied in order to keep the genetic base broad to prevent a decline in vigor. Secondly, it is probably not possible to increase this resistance at a very rapid rate, although more resistance could undoubtedly be attained if all other characteristics were ignored. The important point is, "What is the status of breeding for Aphanomyces resistance?" Note the range of minimum-maximum possible scores. This range represents immunity to the death of all plants. Note also that by definition our resistance check variety gets a rating of 100 which is approximately 1/4 of the scale between death of all plants and immunity under the conditions of these tests. The "susceptible check" used in this test was about equal in resistance to USH20. The rating of 107 is only about 1/10 of the scale units away from the death of all the plants. The testing epidemics are rather severe, and the resistant check with its rating of 100 has enough resistance to be injured very little in all except the most severe field epidemic. Some of the individual progenies had ratings of 85. This is only 18 units (out of 45 on the disease epidemic scale) away from immunity under the conditions of these tests. This degreee of resistance is probably enough to eliminate any loss to black root under presently existing field conditions. The real challenge is to locate lines with this high degree of resistance that also have enough combining ability to produce high yielding commercial hybrids.

Selecting for Resistance to Southern Root Rot

Sclerotium rolfsii, southern root rot, is a devastating disease of sugarbeets where it occurs. It is most prevalent in the southern states, but also occurs as far north as Virginia and Kansas and from Virginia to the Sacramento Valley in California. Dr. Nichole O'Neill developed a technique for testing sugarbeet varieties for seedling resistance in an inoculation chamber (see 1980 Sugarbeet Research Report). Coe and O'Neill used the method to select for resistant plants. Unfortunately the positive correlation between hypocotyl diameter and survival in the inoculation chamber was not recognized at the time the first selections were made. Eighty-eight apparently resistant plants were selected from 2,500 of SP7822-0 tested. These were transplanted to the nursery in 1980. The disease continued to affect the plants, and only 15 survived at harvest time. These plants were brought to the greenhouse where 14 produced at least some seed. Seed was harvested by individual plant. Eight of these were tested in the nursery in 1981. Seven of these eight plus 2 others were tested in the inoculation chamber, and 3 additional progenies are now being tested in the chamber. Results of these tests are presented in Table 3.

TABLE 2. Results of black root tests at Beltsville in 1980-81.

Description	No. Lines Tested	Av. Black Root Rating			Difference Between Highest and Lowest in Tested lines	Minimum-Maximum Possible Scores
		Tested Lines	Resistant Check	Susceptible Check		
E-type MM Polycrosses	59	103	100	106	20	69-115
MM progenies from leaf spot selections	62	104	100	107	17	66-111
MM progenies from black root selections	189	101	100	106	17	66-110
"Soil-free" MM lines	88	99	100	107	14	67-112
F_2 lines from hi-sucrose "soil-free" MM lines	275	104	100	106	21	68-113

*Lowest Rating = Best Resistance

TABLE 3. Results of Sclerotium rolfsii tests at Beltsville in 1980-81.

Variety	Inoculation Chamber Tests			Nursery Test	
	Hypocotyl Dia. ~~Disease Rating~~ % of Check	Comparative Sclerotium* Disease Rating in % of Check	Min.-Max. Disease Range	Comparative Sclerotium* Disease Rating	Min.-Max. Disease Range
7822-0 ck.	100	100	20-102	100	20-121
8122-1	98	83.8	20-102	99	20-121
8122-2	102	92.5	20-102	90	20-121
8122-4	112	96.6	20-102	96	20-121
8122-5	106	90	25-125	86	20-121
8122-6	106	95	25-125	101	20-121
8122-7	95	108	25-125	92	20-121
8122-8	96	100	21-107	Not tested	20-121
8122-9	99	99	21-107	95	20-121
8122-10	93	102	21-107	Not tested	20-121
8122-11		~~Not tested~~	---	84	21-121

*Lower numerical ratings indicate greater resistance.

From the table it is evident that there is no correlation between inoculation chamber tests and nursery tests. However, 6 of the progeny tested in the nursery were more resistant to southern root rot than the parental check line, SP7822-0. The other 2 progenies were not appreciably different from the check. In the greenhouse test, 5 of the 9 progenies were more resistant than the parental sort, 3 were not appreciably different, and 1, SP8122-7, appeared to be more susceptible. SP8122-7 was more resistant than the parental sort in the nursery test. This discrepancy can be explained by the relatively smaller hypocotyl diameter of SP8122-7 making it more vulnerable to the disease in the greenhouse. In the nursery the inoculation was done when the plants were much larger thereby overcoming much, if not almost all, of the vulnerability related to small hypocotyl size. Conversely, SP8122-6 had a relatively large hypocotyl diameter in the greenhouse test and appeared to have some resistance. In the nursery test, however, it appeared to be no more resistant than the parental sort, SP7822-0. Inoculation chamber selections were also made in SP79626-0, a near O-type monogerm line. A pooled progeny of the selected plants was tested in the inoculation chamber together with the parental line. The results were similar to that for SP7822-0. The progeny of the selected plants had a comparative rating of 90 compared to 100 for the parental sort in a minimum-maximum range from 25 to 124.

In conclusion we can say that without a doubt, the greenhouse technique is an effective method for selecting for resistance to Sclerotium rolfsii. A few of the selected plants, however, may produce progeny that are no more resistant than the parental sort. If hypocotyl diameter is taken into consideration when making the selection, it is probable that selection will be even more effective than the selections in these experiments. It is expected that second cycle selections within the resistant progenies will result in a breeding line with fair to good tolerance to the disease. Such selections have been made and are being thermally induced for seed production.

Selecting for Low Content of Nonsucrose Solubles

When sugarbeets were first being developed some 200 years ago, plants with the highest sugar content were selected by specific gravity determinations using a Brix hydrometer. This method does not differentiate between increases in specific gravity due to increased sucrose and increases due to increased other solubles. Hence, the selections were for an increase in total solutes in the juice and would tend to result in plants with a high content of other solubles as well as a high content of sucrose. Attempts to select for high sucrose and low content of other solubles have been quite limited because it appeared to be an impossible task. Our preliminary efforts in this task hinted that nonsucrose solubles content (hereafter designated as NSS) was being influenced by location in nursery plot.

An experiment was conducted keeping a record of the location of each plant. There appeared to be a mosaic pattern of localized areas in the plot containing sugarbeets with a low content of NSS. Roots were selected on the basis of their NSS content in comparison with other roots in the immediate area with the additional requirements that they must be better than average in root weight and better than average in sucrose percentage.

The reason for these two additional requirements is: 1) the negative relationship between root size and sucrose percentage has long been known and we did not want to lose heritable sucrose production potential, and 2) generally sucrose percentage and percent of other solubles tend to move up and down together. (Hence, a plant with good sucrose percentage and a relatively low percent of NSS should be genetically superior in low content of NSS.) Plantings for both selecting and testing were made in 2-ft rows with hand-planted hills 18 inches apart. In 1979, selections were made from SP7822-0. The selections were made from 146 disease-free (except for slight leaf spot infection) plants out of 578 in the testing plot. Table 4 gives average data for the 146 undiseased roots and for the 3 groups of roots selected from them.

TABLE 4. Harvest Data from the 1979 Beltsville Nonsucrose Solubles Selection Test.

Group No.	Group Classification	No. Rts. in Group	Average Root Wt.	Average % Sucrose	Average % NSS
			lb.		
	All apparent disease-free roots	146	3.70	12.11	2.59
(1)	Best NSS selections	5	4.98	13.58	1.89
(2)	2nd choice NSS selections	7	2.93	12.31	1.79
(3)	Average roots	10	3.45	12.93	2.36

Polycross seed increases were made in separate isolations for the three groups of selected plants. We decided that testing group 1 selections against group 2 selections would be a more rigorous test than testing them against group 3 selections (average plants). If our hypotheses were correct, progenies of group 1 selections should be slightly lower in NSS than progenies of group 2 selections. Four progenies from group 1 selections and two progenies from group 2 selections were tested in the 1981 nursery. Progenies of group 1 selections were planted in alternate rows with progenies from group 2 selections. The number of rows of each progeny varied with the quantity of seed available. Roots were harvested and analyzed individually. Results of the test are presented in Table 5.

TABLE 5. Results of 1981 Beltsville Nursery Test for Nonsucrose Solubles Experiment.

Variety No.	No. Rows in Test	No. Roots Analyzed	Average Rt. Wt. lb.	Average Sucrose %	Average NSS* %
80801-1**	6	175	3.15	12.85	2.89
80801-2**	4	114	2.99	13.11	3.17
80800-1***	4	121	3.23	13.78	2.43
80800-3***	2	60	3.60	13.57	2.88
80800-4***	1	30	3.94	13.37	2.68
80800-5***	2	65	3.91	12.63	2.77

* = NSS = Nonsucrose solubles.
** = Progeny of plant selected from group 2 selections.
*** = Progeny of plant selected from group 1 selections.

The average root weight of progenies of group 1 selections was greater than that of progenies of group 2 selections. The average sucrose percentage of three progenies of group 1 selections was greater than group 2 progenies. The other one was lower. The average percent of NSS of three of the progenies of group 1 selections was lower than those of group 2 progenies. The other one was the same as the lower of the two in the group 2 progenies. Since planting the test progenies in alternate rows essentially equalizes the effect of the mosaic soil pattern when averages for entire rows are being considered, we conclude that our selections for low content of NSS was reasonably effective. The apparent relatively good combined root weight and sucrose percentage in three of the group 1 progenies is most probably the result of a negative selection for these characteristics in the group 2 selections. In conclusion, the essential factors in selecting for low content of NSS are: 1) compare the NSS of the root selected with those around it; 2) pick among the larger than average size roots to avoid the effect small root size might have on increasing sucrose percentage; and 3) choose roots that have a relatively high sucrose percentage as well as a relatively low content of NSS.

Development of Soil-Free Sugarbeet Taproots

In 1981, our so-called "soil-free" sugarbeet breeding lines were tested in Michigan for the first time. They were somewhat of a disappointment although they could be removed from the ground with a bit less adhering soil than existing commercial cultivars. In the loam soils at Beltsville, Md., the "soil-free" lines are much better than commercial cultivars with respect to freedom from adhering soil. The heavier soils in the Michigan test pointed out the need for further improvement before "soil-free" lines will do the job they are intended to do--namely, eliminate the need for mechanically removing soil from sugarbeets. To achieve this we will have to produce genetic lines that have almost no rootlets on the harvestable part of the taproot, and the taproot surface will have to be very smooth. It is expected that this will take several cycles of selection and perhaps outcrossing to extra smooth garden beets or stock beets before we are able to produce a truly ideal soil-free sugarbeet. Approximately 40% of the

effort at Beltsville is now directed toward soil-free beets. The best of the soil-free selections at Beltsville in 1981 have been planted in a greenhouse ground bed in order to produce seed in time for nursery tests in 1982.

Cold Temperature Germination Selections

Seed of selected plants and their parental sorts were planted in the cold frame at Beltsville on February 18. The first seedlings from selected plants began emerging 10 and 11 days later; whereas, the first seedlings of parental sorts emerged 14 or 15 days after planting. The 8:00 AM and 3:30 PM temperatures at 1-inch depth during this period are presented in Table 6.

TABLE 6. Cold Frame Soil Temperatures at 1-inch Depth at Beltsville in 1981.

Date	Temperature in °C	
	8:00 AM	3:30 PM
February 18	No reading	17
February 19	7	12
February 20	9	12
February 21	7	11
February 22	No reading	No reading (raining)
February 23	9	11
February 24	5	13
February 25	1	9
February 26	0	12
February 27	-1	11
February 28	1	No reading (raining)
March 1	5	15
March 2	2	12
March 3	-1	8
March 4	0	8
March 5	2	1
March 6	1	4
March 7	-2	3
March 8	-2	5

The 6 days of relatively warm temperatures from February 18 to February 24 undoubtedly were instrumental in the emergence of seedlings at 10 and 11 days. This is, however, fairly rapid emergence at these temperatures. The cold temperatures on March 4 and 5 resulted in many seedlings being killed. Some of the rapidly emerging lines were injured less than others. Perhaps some lines are more resistant to frost injury than others. The parental lines emerged more slowly than progenies of selected plants in greenhouse germination tests at a constant temperature of 23-1/2°C. The slower emergence of the parental lines is not assumed to be caused by heritable improvement of progenies descending from them, but is probably related to the fact that the seed was 2 years older. Tests were conducted in the greenhouse at 23-1/2°C and 10°C using 1980 seed increases of two parental

lines and from selected plants from each of these lines. There was no difference in the speed of emergence at 23-1/2°C or at 10°C. The selection was not effective in these two instances.

Monogerm O-types

Monogerm lines recovered after two or three backcrosses of monogerm O-types to self-incompatible multigerm plants apparently are populations with a relatively low degree of self-compatibility. Many plants are completely self-incompatible and a large percentage set only a few selfed seed. The proportion of self-compatible monogerm plants placed in the isolation plot for O-type indexing purposes seems to be decreasing after each backcross to our multigerm lines. Since we depend on selfed seed to maintain the O-type, we have recently had fewer plants for O-type indexing. In 1981, we found only five new O-types, and the selfed seed of one of these did not germinate. It appears that we shall now have to go into our O-types and select out highly self-compatible plants before backcrossing them to self-incompatible material.